Validation of Aquatic Habitat Quality and Fish Population Assumptions Used to Predict Effects of Activities And Cutthroat Trout Population in Relation to Habitat Changes Items 21 and 41

OBJECTIVES: Monitor fish populations and trends. Determine fish population/habitat relationships. Determine indicators of aquatic habitat quality and effective monitoring methodologies. Monitor the population trends of management indicator species (westslope cutthroat trout) and determine the relation to habitat changes.

DATA SOURCE: Fish population census, habitat inventory and condition, channel structure, redd counts, radio-telemetry and streambank vegetation data. Data collected cooperatively with the Montana Department of Fish, Wildlife, and Parks (MFWP).

FREQUENCY: Annually.

REPORTING PERIOD: 2014-2015.

VARIABILITY: A decline in aquatic habitat quality and/or fish population for more than one year (Item 21); 10 percent difference from projected cutthroat trout yield (Item 41).

INTRODUCTION:

Forest monitoring of the fisheries and aquatic environment in 2014 and 2015 exceeded the minimum requirements set in the 1987 Forest Plan. Research and analysis of fisheries and fish populations since the Forest Plan was signed have shown that the ten percent annual variability noted above is too narrow given the natural annual variation in fish populations. Based on our ongoing long-term monitoring, westslope cutthroat trout populations are stable on the Bitterroot National Forest, while bull trout populations are declining. Habitat quality is either being maintained or improving. Individual measures and evaluations are discussed further in the following sections.

The current emphasis of the Bitterroot National Forest's fisheries monitoring program is to:

1. Monitor population densities and distributions of resident trout.
2. Determine viability trends of bull trout and westslope cutthroat trout populations on the Forest scale.
3. Validate fish/habitat relationships.
4. Locate the strongest bull trout populations and monitor their status.
5. Monitor compliance with Anadromous Fisheries (PACFISH) and Inland Native Fish (INFISH) requirements.

MONITORING RESULTS AND EVALUATION:

The following monitoring was accomplished in 2014 and 2015 and is discussed and **evaluated** in this section:

- Fish Habitat Inventories
- Fish Population Monitoring
- Mountain Lake Surveys
- Viability of Bull Trout and Westslope Cutthroat Trout Populations
- Water Temperature Monitoring
- Bull Trout Redd Surveys
- Mussel Surveys
- Research
- Culvert Inventories and Replacements

- Project Level Monitoring of Fisheries/Watershed Improvement Projects

FISH HABITAT INVENTORIES:

Table 1 lists the fisheries habitat inventories that were conducted by Forest fisheries biologists in support of project planning and monitoring efforts in 2014 and 2015. The inventories supply information used at a variety of scales to address short-term and long-term aquatic issues on and off the Forest.

Table 1 - Fish Habitat Inventories Conducted in 2014 and 2015

Stream	District	Inventory Length (mi.)	Inventory Method[1]	Purpose
Swift Creek	Sula	1.8	I-walk	NEPA analysis
Reynolds Creek	Sula	0.7	I-walk	NEPA analysis
Reynolds Creek, tributary 2.2	Sula	0.4	I-walk	NEPA analysis
Reimel Creek	Sula	1.9	I-walk	TMDL monitoring
Laird Creek	Sula	0.4	I-walk	TMDL monitoring
Gilbert Creek	Sula	0.8	I-walk	TMDL monitoring
West Fork Camp Creek	Sula	0.1	I-walk	Fill data gap
West Fork Camp Creek	Sula	1.2	I-walk	Fill data gap
Bertie Lord Creek	Sula	1.6	I-walk	NEPA analysis
Bertie Lord Creek	Sula	1.0	I-walk	NEPA analysis
Bertie Lord Creek, tributary 0.4	Sula	1.0	I-walk	NEPA analysis
Tepee Creek	Sula	0.7	I-walk	NEPA analysis
Warm Springs Creek	Sula	1.6	I-walk	Fill data gap
East Fork Bitterroot River	Sula	1.9	I-walk	TMDL monitoring
Hughes Creek	West Fork	1.0	I-walk	TMDL monitoring
Hughes Creek	West Fork	2.6	I-walk	TMDL monitoring
Buck Creek	West Fork	0.2	I-walk	TMDL monitoring
Overwhich Creek	West Fork	2.9	I-walk	NEPA analysis
Cayuse Creek (Selway trib)	West Fork	0.2	I-walk	NEPA analysis
Sheep Creek (Selway trib)	West Fork	0.2	I-walk	NEPA analysis
Total		**22.2**		

In 2014 and 2015, fish habitat inventories were conducted in 22.2 miles of streams on the Sula and West Fork Ranger Districts (Table 1). Habitat data was collected using the I-walk methodology, which is a reach-based walk-through inventory method which focuses on collecting basic INFISH Riparian Management Objective (RMO) data. Inventories were conducted to gather baseline habitat data in support of various NEPA projects, and in designated TMDL monitoring reaches, to monitor the pool and large woody debris (LWD) supplemental targets in the Bitterroot Headwaters TMDL. The Monitoring Strategy in the Bitterroot Headwaters TMDL recommends re-survey of the monitoring reaches at least once every five years, which is being done. Figures 1 and 3 show the trend in pool and large wood frequencies in the TMDL reaches that were surveyed in 2004, 2009, and 2014. Figures 2 and 4 show the trend in pool and large wood frequencies in the TMDL reaches that were surveyed in 2005, 2010, and 2015.

[1] I-walk: A survey method that looks at pool quality, substrate composition, large wood, and pools per mile to quantify fish habitat as described by INFISH.

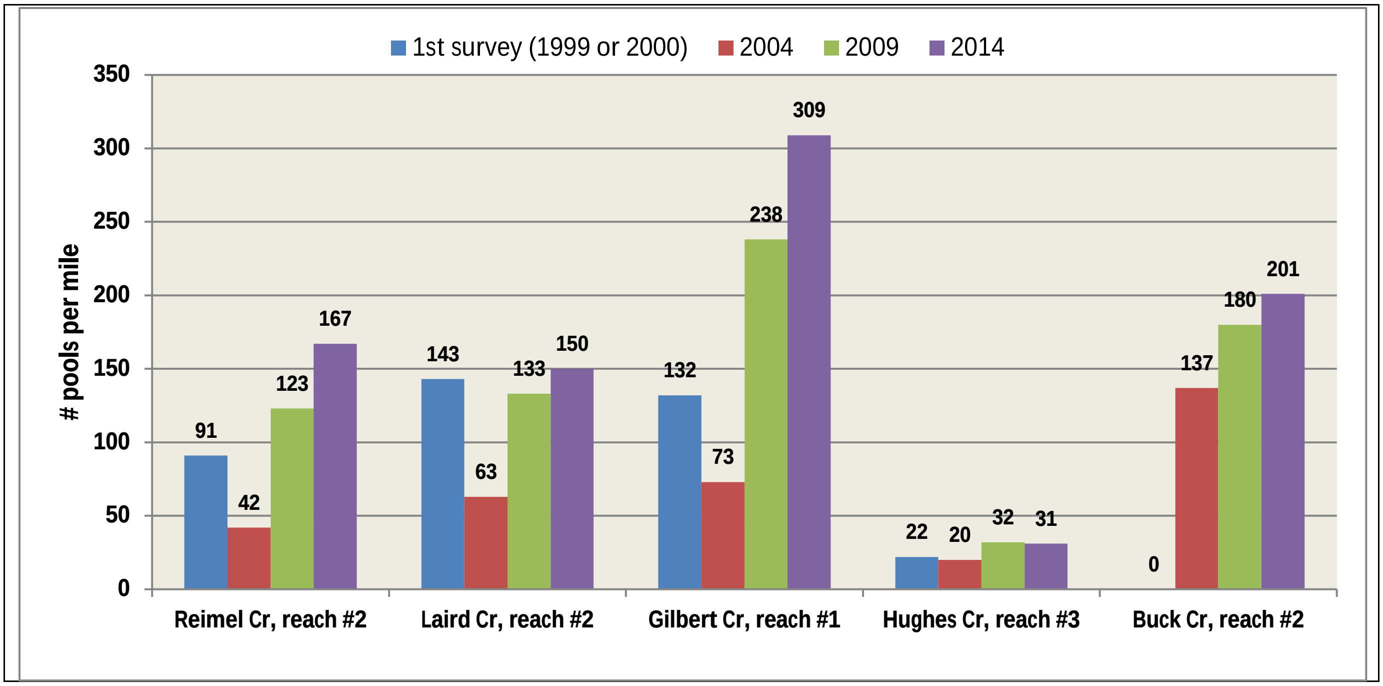

Figure 1 – Pool Frequencies in Bitterroot Headwater TMDL Monitoring Reaches Surveyed in 2004, 2009, and 2014 (most of these reaches were initially surveyed in 1999 or 2000)

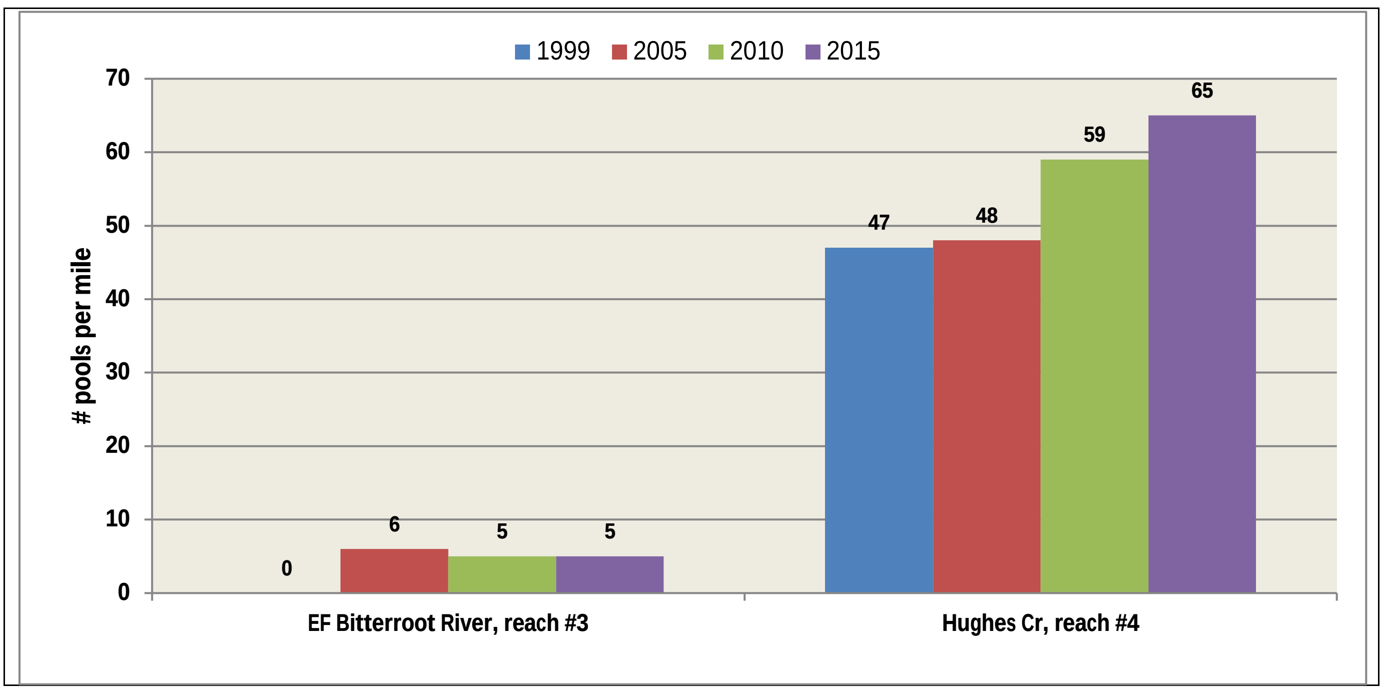

Figure 2 – Pool Frequencies in Bitterroot Headwater TMDL Monitoring Reaches Surveyed in 2005, 2010, and 2015 (Hughes Creek reach #4 was initially surveyed in 1999)

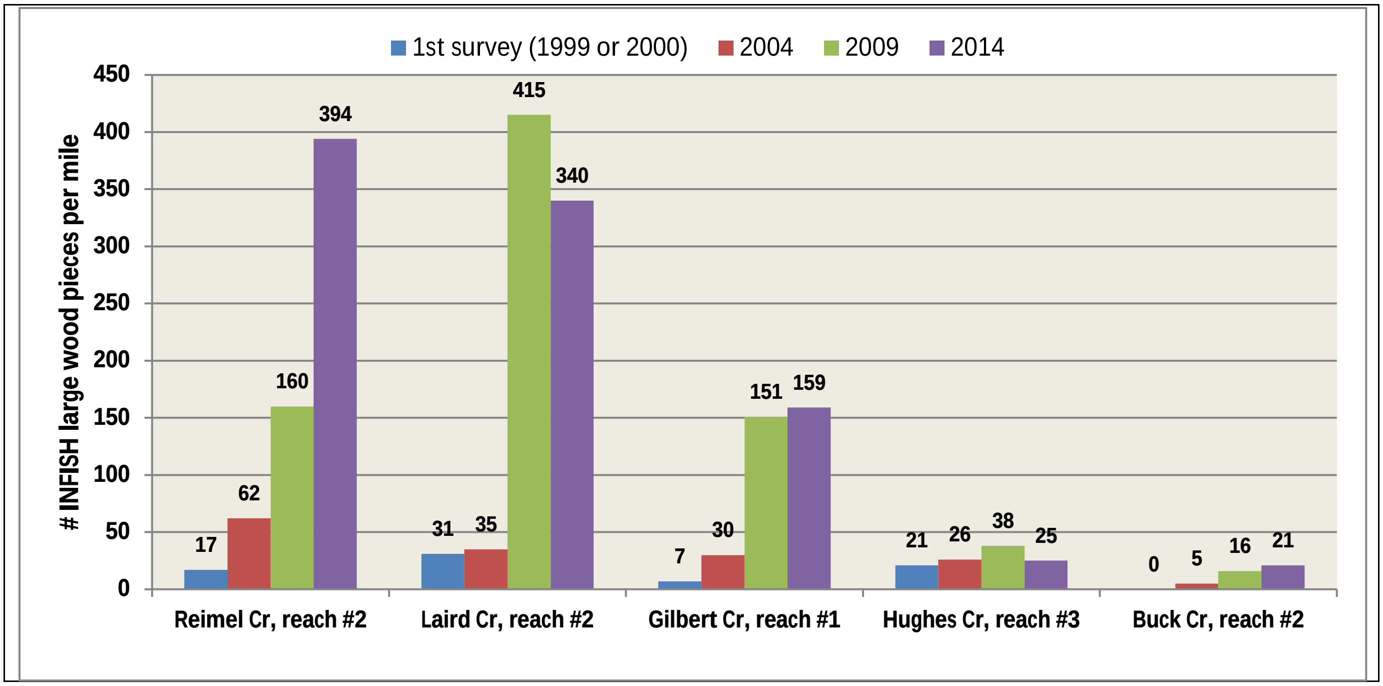

Figure 3 – Large Wood Frequencies in Bitterroot Headwater TMDL Monitoring Reaches Surveyed in 2004, 2009, and 2014 (most of these reaches were initially surveyed in 1999 or 2000)

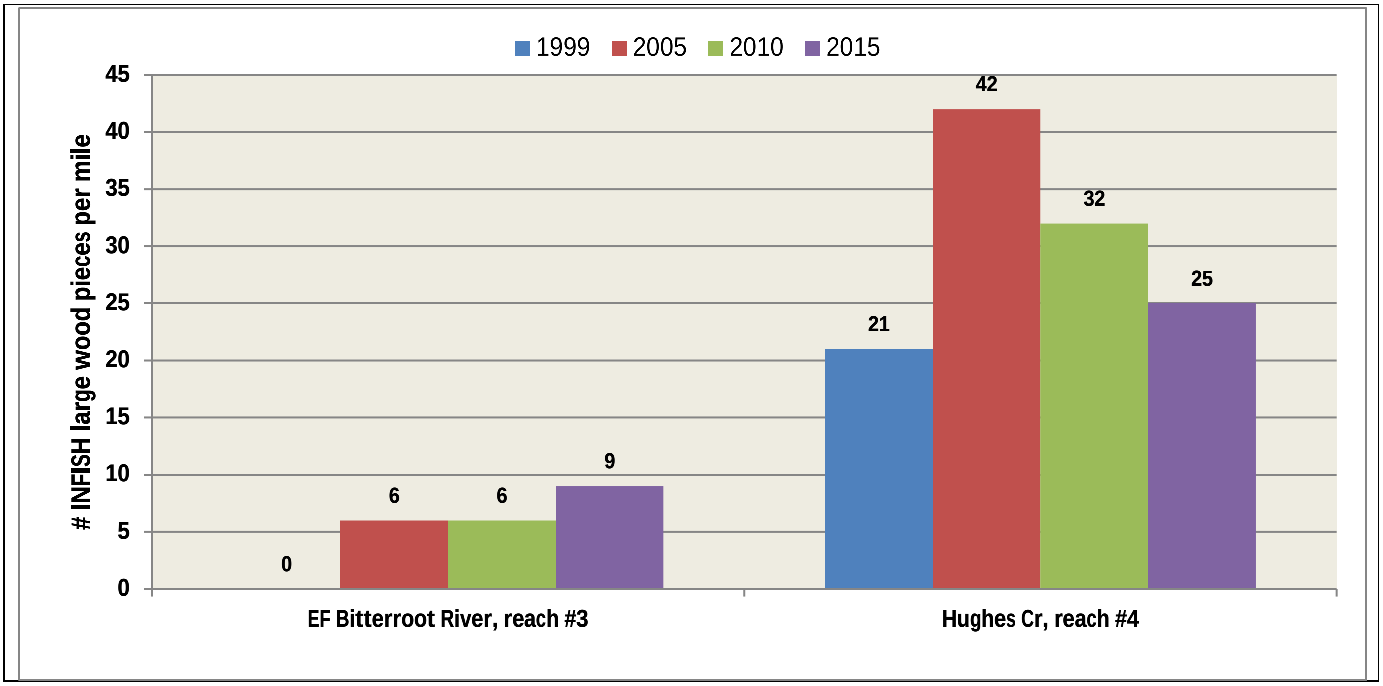

Figure 4 – Large Wood Frequencies in Bitterroot Headwater TMDL Monitoring Reaches Surveyed in 2005, 2010, and 2015 (Hughes Creek reach #4 was initially surveyed in 1999)

<u>Reimel Creek, reach #2</u>: This reach is a 1.9-mile long C4 section of Reimel Creek between the Forest boundary and Diggins Creek. The reach was burned by high severity fire in August, 2000. Reimel Creek was determined to be impaired by sediment in the Bitterroot Headwaters TMDL. Reach #2 was surveyed in 2000, 2004, 2009, and 2014. Post-fire channel instability and bedload movement initially reduced the number of pools between 2000 and 2004 (Figure 1), but since then, the large influx of fire-killed snags into the stream channel (Figure 3) has resulted in substantial increases in the number of pools (Figure 1) and the amount of large wood (Figure 3). At present, most of the burned pine snags have fallen over, but some of the larger spruce and fir snags are still standing along the stream banks. Numerous logs currently bridge the stream channel and are too high above the waterline to function as instream large wood at this time. Some of these logs will eventually be recruited to the stream channel in future years as they rot and fall into the channel.

Laird Creek, reach #2: This reach is a 0.4-mile long B4 section of Laird Creek between the Forest boundary and Gilbert Creek. The reach was burned by high severity fire in August, 2000. Laird Creek was determined to be impaired by sediment in the Bitterroot Headwaters TMDL. Reach #2 was surveyed in 2000, 2004, 2009, and 2014. Laird Creek was hit with a series of large post-fire mudslides in July, 2001. The mudslides paved the stream channel and filled the pools, which resulted in a decline in the number of pools between 2000 and 2004 (Figure 1). Since then, the large influx of fire-killed snags into the stream channel (Figure 3) has resulted in more than a doubling in the number of pools (Figure 1). Pool frequency in 2014 was slightly higher than its pre-2000 fire level (Figure 1). The recruitment of fire-killed snags to the stream channel increased dramatically between 2004 and 2009, then slightly decreased between 2009 and 2014 (Figure 3). At present, most of the burned pine snags have fallen over, but some of the larger spruce and fir snags are still standing along the stream banks. Numerous logs currently bridge the stream channel and are too high above the waterline to function as instream large wood at this time. Some of these logs will eventually be recruited to the stream channel in future years as they rot and fall into the channel.

Gilbert Creek, reach #1: This reach is a 0.8-mile long A4 section of Gilbert Creek between Laird Creek and two headwater forks. The reach was burned by high severity fire in August, 2000. Gilbert Creek was determined to be impaired by sediment in the Bitterroot Headwaters TMDL. Reach #2 was surveyed in 2000, 2004, 2009, and 2014. Gilbert Creek was hit with post-fire mudslides in July, 2001. Similar to nearby Laird Creek, the mudslides paved the Gilbert Creek stream channel and filled the pools, which resulted in a decline in the number of pools between 2000 and 2004 (Figure 1). Since then, the large influx of fire-killed snags into the stream channel (Figure 3) has roughly quadrupled the number of pools (Figure 1). Pool frequency in 2014 was more than double its pre-2000 fire level (Figure 1). The recruitment of fire-killed snags to the stream channel increased dramatically between 2004 and 2009, then slightly increased between 2009 and 2014 (Figure 3). At present, most of the burned pine snags have fallen over, but some of the larger spruce and fir snags are still standing along the stream banks. Numerous logs currently bridge the stream channel and are too high above the waterline to function as instream large wood at this time. Some of these logs will eventually be recruited to the stream channel in future years as they rot and fall into the channel.

Hughes Creek, reach #3: Reach #3 is a 2.6-mile long C4 section of Hughes Creek between the Forest Road 5685 bridge and Chrandal Creek. Hughes Creek was determined to be impaired by both sediment and thermal modification in the Bitterroot Headwaters TMDL. Reach #3 was surveyed in 1999, 2004, 2009, and 2014. The data suggests that there has been minimal change in pools and large wood over the past 15 years (Figures 1 and 3).

Hughes Creek, reach #4: Reach #4 is a 1.0-mile long C4 section of Hughes Creek between Chrandal Creek and the lower end of private land. Hughes Creek was determined to be impaired by both sediment and thermal modification in the Bitterroot Headwaters TMDL. Reach #4 was surveyed in 1999, 2005, 2010, and 2015. Pools have gradually increased in the reach since 1999 (Figure 2); large wood initially increased between 1999 and 2005, but has decreased since then (Figure 4).

Buck Creek, reach #2: Buck Creek is a small (base flow wetted width is about 3 feet) tributary to the West Fork Bitterroot River with high sediment infill and shallow, poorly-defined pools. Buck Creek was determined to be impaired by sediment in the Bitterroot Headwaters TMDL. The TMDL monitoring reach is a 1000-foot long B4 reach that starts at the Forest boundary. The reach was surveyed in 2004, 2009, and 2014. The data indicates that pools and large wood have increased over the past decade (Figures 1 and 3); however, the apparent increase in pools may be more attributable to sampling bias than actual change. Pools are difficult to count in small, shallow streams such as Buck Creek, and there is often a lot of sampler variability from year to year and sampler to sampler. We try to have the same people conduct the repeat surveys, but even that doesn’t eliminate bias. Counting large wood pieces is usually a more reliable indicator in repeat surveys. The increase in large wood that has occurred in the stream channel over the past decade is attributable to increased recruitment of beetle-killed trees from the adjacent riparian area.

East Fork Bitterroot River, reach #3: This reach is a 1.9-mile long C3 section of the East Fork Bitterroot River between Robbins Gulch and Medicine Tree Creek. The East Fork Bitterroot River was determined to be impaired by both sediment and thermal modification in the Bitterroot Headwaters TMDL. Reach #3 was surveyed in 2005, 2010, and 2015. Pools have stayed about the same over the past ten years (Figure 2); a small increase in large wood was observed in 2015 (Figure 4).

FISH POPULATION MONITORING:

The Forest Plan recommends monitoring fish populations in six streams annually to meet the Forest objectives. In 2014, fish populations were monitored in 13 streams at 17 monitoring reaches. In 2015, fish populations were monitored in 15 streams at 18 monitoring reaches.

At each monitoring reach, we have set a goal of monitoring trout populations for at least three years to serve as a baseline for future population studies. This “pulsed” monitoring technique is necessary for assessing long-term changes in fish populations (Bryant, 1995). Complete methods are described in Clancy (1998). As displayed in Table 2 most of the reaches monitored in 2014 and 2015 have been sampled for at least three years, and many have been sampled between 5-10 years. Since 1989, the Forest has accomplished its fish population monitoring requirements cooperatively with MFWP biologists.

Table 2 summarizes the fish population estimates that were conducted on the Forest between 1989 and 2015. Years in which a population estimate was conducted in a monitoring reach are denoted with **X**.

Table 2 - Fish Population Estimates Conducted Between 1989 and 2015

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Ambrose 8.4																				X							
Ambrose 8.6																				X							
Andrews 0.5													X	X	X												
Bear 6.0			X																								
Beaver 0.3			X	X																X				X			
Beaver 3.1																								X	X	X	
Bertie Lord 0.2		X	X								X		X	X	X	X	X	X	X				X	X			X
Big 6.5				X																							
Blue Joint 5.9						X	X															X					X
Boulder 2.0				X														X									
Bunkhouse 1.3																	X										
Burnt Fork 19.7						X		X				X						X	X	X			X				
Cameron 6.1					X						X								X			X					X
Cameron 10.1		X									X		X	X	X	X				X		X					
Camp 2.3															X	X	X	X	X		X		X		X		
Camp 3.2										X																	
Camp 6.6									X														X				
Castle 0.1																		X									
Chaffin 3.1		X	X														X		X								X
Chicken 1.0												X	X	X	X	X			X			X				X	
Coal 1.3		X												X	X	X	X										X
Daly 0.7	X	X						X			X		X	X	X			X	X					X			
Deer 0.3																					X		X		X		
Divide 0.1	X	X	X					X					X	X	X												
Doran 0.1					X																						
EF Bitterroot 2.5										X		X	X		X	X	X	X	X			X		X		X	
EF Bitterroot 12.0		X					X		X			X	X	X	X	X	X	X	X		X		X		X		X
EF Bitterroot 19.1				X																		X					
EF Bitterroot 25.6				X													X				X					X	
EF Bitterroot 28.4		X																									
EF Bitterroot 31.4				X		X				X		X	X	X	X					X			X			X	

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
EF Camp 0.4																					X	X	X				
East Piquett 0.2																		X	X	X							
Fred Burr 9.0										X																	
Gilbert 0.1														X	X	X											
Gold 0.3		X	X					X																			
Guide 0.1																	X	X	X			X					
Hart 2.8													X	X	X					X							
Hughes 1.6										X	X													X			
Hughes 9.0								X			X																
Jennings Camp 0.5																	X	X	X			X					
Johnson 0.7			X																	X							
Kootenai 0.3										X																	
Laird 1.4		X	X									X		X	X	X	X				X						
Laird 2.3												X		X	X	X	X							X			
Lavene 0.2																		X	X	X				X	X		
Lick 1.9		X	X	X			X		X		X		X		X		X										
Lick 2.1							X		X				X														
Little Blue Joint 1.4												X	X	X	X	X	X						X				
Little Boulder 1.4																						X	X		X		
L. Sleeping Child 4.2													X	X		X											
Little Tin Cup 1.3					X																						
Little West Fork 1.3				X												X	X	X									
Little West Fork 3.1				X																	X						
Martin 1.3			X	X	X	X			X		X		X	X	X							X			X		
Martin 7.5				X	X	X	X						X		X											X	
Maynard 0.1													X	X	X	X											
Meadow 0.3																						X				X	
Meadow 5.2		X	X																								X
Meadow 5.6	X	X	X			X	X	X				X	X	X	X	X		X	X	X			X			X	
Meadow 7.3	X	X	X										X	X	X							X					X
Medicine Tree 1.5													X	X	X	X	X				X	X				X	
Mine 0.2										X	X		X	X	X										X		
Moose 1.4			X	X	X				X		X		X	X	X			X					X			X	
Moose 3.6				X	X	X												X	X	X					X		
NF Sheephead 0.5					X																X						
North Rye 1.9	X	X	X					X	X			X	X	X	X	X	X	X						X			X
Nez Perce 1.2												X	X											X			
Nez Perce 9.8				X								X	X	X	X									X			
Nez Perce 11.8				X																	X			X			
Overwhich 2.0					X	X	X			X	X							X									
Overwhich 8.9					X																						
Pierce 0.5																		X	X	X				X	X		
Piquett 1.3		X	X										X	X	X		X	X	X	X							X
Praine 1.0							X					X	X	X	X	X					X			X			
Railroad 1.4				X																							
Reimel 2.6		X	X	X								X	X	X	X	X				X			X				
Reimel 2.9		X	X	X																							
Reimel 3.8		X	X	X								X	X	X	X								X				
Rye 6.6													X	X	X	X	X						X				X

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Rye 12.4	X	X	X					X	X			X	X	X	X	X	X	X			X			X			X
Salt 0.2								X	X																		
Sheep 0.2			X																	X					X		
Sheephead 0.2																X	X	X						X			
Sheephead 2.5					X																X						
Skalkaho 0.4		X																									
Skalkaho 5.8								X														X					
Skalkaho 8.1	X																										
Skalkaho 12.5									X																		
Skalkaho 13.1			X	X		X				X	X		X		X										X		
Skalkaho 16.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Skalkaho 17.2												X															
Skalkaho 20.6			X	X	X	X							X		X												X
Slate 1.6			X	X	X						X		X	X	X						X						X
Sleeping Child 1.9					X																						
Sleeping Child 4.5									X																		
Sleeping Child 10.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sleeping Child 14.5	X	X	X					X					X	X	X												
Sleeping Child 16.9	X	X	X																								
Soda Springs 0.3																X	X	X									
Sweathouse 5.7			X																								
Swift 0.7							X						X	X	X									X		X	
Tepee 0.9																	X	X	X				X	X			
Threemile 2.6			X																								
Threemile 3.9				X																							
Threemile 6.3			X																								
Threemile 8.3			X													X						X					
Threemile 10.0																X						X					
Threemile 12.6																		X						X			
Threemile 15.3								X		X			X														
Tin Cup 7.2				X																		X					
Tolan 2.1		X	X										X	X	X			X								X	
Tolan 5.1	X	X	X					X	X				X	X	X	X			X					X			
Tolan 7.3	X												X	X	X												
Trapper 1.7				X																							
Trapper 3.5				X													X										
Two Bear 0.8			X										X	X	X	X								X			
Ward 0.7																		X	X								
Warm Springs 3.5				X	X	X	X					X	X	X	X	X					X					X	
Warm Springs 5.6		X		X																							
Warm Springs 7.4				X		X	X											X	X	X						X	

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Watchtower 0.1																X	X	X						X			
Watchtower 0.8				X																	X						
Waugh 0.7		X	X										X	X	X	X	X										X
WF Bitterroot 1.2							X		X	X				X					X				X				X
WF Bitterroot 22.2										X																	
WF Bitterroot 34.0			X	X			X			X	X											X					
WF Bitterroot 40.0			X										X	X	X												
WF Camp 0.3					X								X	X	X				X				X				
Willow 12.1		X																		X							
Woods 0.3			X																								
Woods 0.9								X	X				X	X	X					X				X			
Woods 4.4																							X	X	X	X	

The following narratives summarize our most current knowledge of the fish populations in the monitoring reaches that were sampled in 2014 and 2015.

- **Beaver Creek 3.1:** This reach was established in the middle portion of Beaver Creek following the 2011 Saddle Complex fire. The purpose for establishing this reach is to monitor post-fire fish recovery in Beaver Creek. The reach was burned at moderate to high severity in August, 2011, and a large fish kill occurred. The reach was sampled in 2012, 2013, and 2014. The westslope cutthroat trout population has exhibited a strong post-fire recovery. Westslope cutthroat trout numbers increased from 27 (2012) to 128 (2013) to 185 (2014). Two juvenile bull trout were captured in 2012, and five in 2013. No bull trout were captured in 2014.

- **Bertie Lord Creek 0.2:** This reach is located near the confluence with the East Fork Bitterroot River. It was sampled in 1990-91, 1999, 2001-07, 2011-12, and 2015. Westslope cutthroat trout currently make up nearly all of the fish in the reach. The number of westslope > 4 inches has fluctuated a lot over the years. In 2015, a large number of cutthroat trout between 3 and 3.99 inches were captured (113 per 600 feet), but the number of cutthroat trout > 4 inches was lower than the long-term average. Brook trout are present in the reach in low numbers. Prior to 2002, the number of brook trout captured per year ranged between 12 and 16; since 2002, the range has been 0 to 4 per year. The only year that we were able to calculate a statistically valid brook trout estimate was 1999. Bull trout are incidental and rare in the reach. One bull trout was captured in 1990, 1999, 2002, and 2006. Four bull trout were captured in 2011. No bull trout were captured in 2001, 2003-05, 2007, 2012, and 2015.

- **Blue Joint Creek 5.9:** This reach starts a short distance upstream of the Blue Joint trailhead. It was sampled in 1994-95, 2010, and 2015. In 2015, the westslope cutthroat trout population estimate was higher than in the past. More bull trout were captured in this reach in 2010 and 2015 than in previous years.

- **Cameron Creek 6.1:** This reach is located on Forest Service land below the Shining Mountain Ranch. It was sampled in 1993, 1999, 2007, 2010, and 2015. Brook trout are the most numerous trout species in the reach, with lesser numbers of westslope cutthroat trout and longnose suckers. In 2015, the number of large (6+ inches) brook trout was similar to previous years, but the number of smaller (< 6 inches) brook trout was much lower than previous years. Overall brook trout numbers in 2015 were lower than in previous years. Westslope cutthroat trout numbers were slightly higher in 2015 than in previous years. One brown trout was captured in the reach in 2015. Western pearlshell mussels are present in the reach. The low stream flows that occurred in summer 2015 made it easier for predators (raccoons, mink, herons) to find and kill mussels. Newly opened shells were found throughout the reach.

- **Chaffin Creek 3.1:** This reach is located downstream of the Chaffin Creek trailhead. It was sampled in 1990-91, 2005, 2007 and 2015. A November 2006 flood caused substantial bedload movement and abandonment of the historic channel throughout much of the reach. In 2007, a new channel was forming where the stream was flowing across the forest floor. Westslope cutthroat are the most numerous salmonid in this reach, both before and after the flood. The number of cutthroat has been stable to slightly declining since sampling began. In 2015, the number of westslope cutthroat, bull trout and brook trout were similar to past estimates.

- **Chicken Creek 1.0:** This reach is located at the mouth of the Chicken Creek canyon. It was sampled for the first time in 2000, shortly after being severely burned by the fires of 2000. Additional sampling occurred in 2001-04, 2007, 2010, and 2014. Westslope cutthroat trout are abundant in the reach, and have bounced back strong following the 2000 fires and 2001 mudslides. Over the past three surveys, the estimated number of westslope cutthroat trout > 4 inches was 218 (2007), 310 (2010), and 264 fish (2014) per 1000 feet. For perspective, only 28 westslope of all sizes were found in the reach in October, 2000. The estimated number of brook trout > 4 inches has not returned to its October, 2000 abundance level of 86 fish per 1000 feet. Since then, the estimated number of brook trout > 4 inches has ranged between 24 (2003) and 60 fish (2010). In 2014, the estimated number was 26 fish per 1000 feet. Since 2000, the number of bull trout captured in the reach has ranged between 1 and 15. Over the last three surveys, the number of bull trout captured was 10 (2007), 15 (2010), and 8 fish (2014). Bull trout and bull X brook hybrids are also present in the reach at low numbers. Sculpin are common in the reach. Longnose suckers spawn in the reach during mid-summer.

- **Coal Creek 1.3:** This reach is located at the Forest/DNRC boundary. It was sampled in 1990, 2002-05, and 2015. Westslope cutthroat trout are the most numerous fish species in the reach; brook trout are also present but not as numerous. Bull trout and/or bull X brook hybrids are incidental and rare in the reach. Sculpin are common. In 2015, the number of westslope cutthroat trout > 4 inches was similar to past years, but there were fewer cutthroat between 3-4 inches. Brook trout numbers were higher in 2015 than previous years. In 2015, the number of westslope cutthroat trout captured in the reach outnumbered the number of brook trout by about a 5 to 1 ratio.

- **East Fork Bitterroot River 12.0:** This reach is located in the U.S. Highway 93 canyon. It starts below Maynard Creek and extends downstream for 0.5 miles. It has been sampled in 1990, 1995, 1997, 2000-07, 2009, 2011, 2013 and 2015. The reach has traditionally been dominated by rainbow trout, but the fish community has changed over the past decade as rainbow trout have declined and brown trout have increased. The brown trout estimate in 2015 was the largest ever for fish over 11 inches, but indicated low numbers of fish less than 11 inches. The 2015 rainbow trout population estimate indicates that the rainbow trout population remains lower than in the past. Whirling disease is believed to be responsible for the rainbow trout decline. The westslope cutthroat trout population appears to be stable, but small. Juvenile bull trout are usually captured in the reach each year, but never in large numbers, and all are usually < 12 inches in length.

- **East Fork Bitterroot River 25.6:** This reach starts near Colvert Creek and ends at the USFS Jennings Campground. It has been sampled in 1992, 2005, 2009, and 2014. In 2005, 2009 and 2014, the number of westslope cutthroat trout was significantly higher than in 1992. This increase may be due to more restrictive fishing regulations. In 2014, current levels of other species (bull, brown, rainbow, and brook trout and mountain whitefish) were similar to past years.

- **East Fork Bitterroot River 31.4:** This reach is located near the Anaconda Pintler Wilderness trailhead. It has been sampled in 1992, 1994, 1998, 2000-03, 2008, 2011, and 2014. The westslope cutthroat population estimates have been fairly stable since sampling began. However, the bull trout population estimates indicate a significant decline in the past few years. Due to the low number of bull trout handled, we have been unable to calculate a population estimate the past few years. Also, brown trout are now found here in small numbers. When sampling began in the 1990's, no brown trout were captured at this site.

- **Martin Creek 7.5:** This reach is located in the upper portion of Martin Creek. It starts a short distance upstream from the old crossing of Forest Road 8177. The reach was sampled in 1985-86, 1992-95, 2001, 2003, and 2014. Westslope cutthroat trout and bull trout are the only fish species that have been found in the reach. In 2014, the westslope cutthroat trout population (common) was similar to past years. The number of bull trout in the reach appears to have declined since the mid-1980s. In the 1985-86 and 1992 surveys, the number of bull trout captured ranged between 26 and 60 fish. Since then, the number captured has ranged between 8 and 19 fish. In 2014, 12 bull trout were captured.

- **Meadow Creek 0.3:** This reach is located near the mouth of Meadow Creek. It was sampled in 2010 and 2014. Westslope cutthroat trout and bull trout were the only fish species found in the reach. Both species were less abundant in 2014 than 2010.

- **Meadow Creek 5.2:** This reach is located inside of the 1996 riparian exclosure fence. It was sampled in 1990, 1991, and 2015. Westslope cutthroat trout and bull trout are present in the reach. The westslope cutthroat trout population was similar to levels found in the early 1990's, while the bull trout population has declined.

- **<u>Meadow Creek 5.6:</u>** This reach is located upstream of the Road 5759 bridge. It was sampled in 1989-91, 1994-96, 2000-04, 2007-08, 2011, and 2014. Westslope cutthroat trout and bull trout are present in the reach. The westslope cutthroat trout and bull trout populations have been declining during the past few years.
- **<u>Meadow Creek 7.3:</u>** This reach is located in upper Meadow Creek downstream of Balsam Creek. It has been sampled in 1989-91, 2001-03, 2010, and 2015. The reach was burned at high severity in the 2000 fires. Westslope cutthroat trout and bull trout have usually been the only fish species found in the reach. One brown trout (the same fish in the same pool) was found in the reach in 2002 and 2003. The westslope cutthroat trout population has made a strong recovery since the 2000 fires. Cutthroat numbers in 2010 and 2015 were more than double the pre-2000 fire levels, particularly the number of larger cutthroat > 8 inches in length. Bull trout numbers have been declining since 2003. The number of bull trout captured in 2015 (21) was less than half the 2010 number (52) and about a third of the 2003 number (65). Adult migratory bull trout are sometimes found in this reach.
- **<u>Medicine Tree Creek 1.5:</u>** This reach starts at the Forest boundary. The 2000 fires and 2001 mudslides killed most of the fish in this stream. Since then, the westslope cutthroat trout population has exhibited a strong recovery, despite being at least partially isolated from the East Fork Bitterroot River by several culvert barriers on private land. The estimated number of westslope cutthroat trout (> 4 inches) per 1000 feet was one (2001), two (2002), 14 (2003), 78 (2004), 71 (2005), 101 (2009), 63 (2010), and 104 fish (2014). Non-native trout have not been found in the reach with the exception of one rainbow trout in 2004. A single westslope X rainbow hybrid was found in 2005 and 2014.
- **<u>Moose Creek 1.4:</u>** This reach is located downstream of the Lick Creek confluence. It was sampled in 1991-93, 1997, 1999, 2001-03, 2006, 2011, and 2014. The number of westslope cutthroat trout was below the long-term range in 2014. Although we captured similar numbers of bull trout as in past years, we were unable to collect a bull trout population estimate in 2014.
- **<u>North Rye Creek 1.9:</u>** This reach is located near the Forest boundary. It was sampled in 1989-91, 1996-97, 2000-06, 2012 and 2015. The 2000 fires and 2001-02 mudslides killed most of the fish in this reach. The westslope cutthroat population has recovered to its pre-fire levels. In contrast, brook trout abundance has decreased and remained at low levels since the fires and mudslides. In 2015, brook trout are still present in very small numbers and the westslope cutthroat trout population is stable.
- **<u>Piquett Creek 1.3:</u>** This reach starts upstream of the Forest boundary. The reach was sampled in 1990-91, 2001-03, and 2005-08, and 2015. Westslope cutthroat trout are common in the reach, and their numbers have remained stable over the last 25 years. Brook trout were once the dominant species in the reach, but have declined to the point that we were unable to capture enough brook trout to calculate statistically valid estimates in 2007, 2008, and 2015. Bull trout and bull X brook hybrids are incidental and rare in the reach, as are rainbow trout and brown trout.
- **<u>Rye Creek 6.6:</u>** This reach is located near the Forest boundary. It was sampled in 2001-05, 2011, and 2015. In 2001, post-fire mudslides killed most of the fish in this reach. In 2002, both brook and cutthroat trout were observed, but there were very few brook trout. No brook trout were found in the reach in 2003 or 2004, which is odd because brook trout are common a couple of miles upstream and downstream of the reach. By 2005, westslope cutthroat trout numbers had recovered to near pre-mudslide levels, but brook trout numbers remained low. In 2015, the westslope cutthroat population remains stable and the brook trout population is increasing, but is still not at pre-fire levels.
- **<u>Rye Creek 12.4:</u>** This reach is located in upper Rye Creek above the Forest Road 75 Bridge. It has been sampled in 1989-1991, 1996-97, 2000-06, 2009, 2012 and 2015. The reach was burned at moderate-to-high severity in 2000, but was generally spared from mudslide effects. Following the fires, the westslope cutthroat trout population declined in 2001, but rebounded to just below its pre-fire level in 2003. Bull trout were present in low numbers before and immediately after the fires, but have not been found since 2000. Over the same time period, brook trout numbers have increased, and in 2003-2006, they made up almost 20% of the fish captured in the reach. In 2009, more brook trout were captured than in 2006; however, not enough recaptures were caught to estimate the population. This is the one reach in the burned area where brook trout have clearly increased since the 2000 fires. In 2015, both westslope cutthroat and brook trout numbers were similar to recent estimates.

- **Skalkaho Creek 16.8:** This reach is located near the Railroad Creek confluence. It has been sampled every year since 1989. Bull trout and westslope cutthroat trout population numbers are similar to pre-2000 fire levels. The number of larger westslope cutthroat trout and bull trout increased between 2000-11 with the implementation of catch and release fishing regulations and have remained stable since then.
- **Slate Creek 1.6:** This reach is located along Forest Road 1133 downstream of Elk Creek. It has been sampled in 1991-93, 1999, 2001-03, 2009 and 2015. In 2015, numbers of westslope cutthroat trout, bull trout and brook trout were lower than in past years. In September 2013, a large thunderstorm on burned areas (2000 fires and 2007 Rombo fire) in the watershed caused high channel erosion and substantial bedload movement. It is suspected that the lower fish numbers we observed in 2015 are related to this event.
- **Sleeping Child Creek 10.2:** This reach is located near the Sleeping Child Hot Springs. It has been sampled every year since 1989. In 2001, post-fire mudslides killed most of the fish in the reach. The westslope cutthroat trout population recovered to its pre-mudslide level in 2004-05. In the past few years, the number of westslope cutthroat has been stable, but bull trout have declined and leveled off at low numbers. Brown trout were not captured in this reach until 1997 and were not seen in large numbers until recently. Brown trout are now well established in this section and continue to increase in number.
- **Swift Creek 0.7:** This reach is located near the Swift Creek trailhead. It was sampled in 1996, 2001-03, 2012, and 2014. The reach was unburned in 2000, but much of the watershed upstream of the reach was burned at high severity. In 2014, the population of westslope cutthroat was similar to past years, but the number of bull trout continues to decline.
- **Tolan Creek 2.1:** This reach starts at the Forest boundary. It was sampled in 1985-86, 1990-91, 2001-03, 2006, and 2014. In 2014, the westslope cutthroat trout population (abundant) was similar to past years. No bull trout were captured in 2014. In previous years, 1 to 7 bull trout were found in the reach. A few brook trout (8) and rainbow trout (4) were captured in 2014. Brook trout numbers are lower now than they were in the 1985-86 and 2002-03 surveys (22-38 fish). No brown trout were seen in 2014. The only brown trout sighting occurred in 2001 (1 fish).
- **Warm Springs Creek 3.5:** This reach is located along Forest Road 370 downstream of Lupine Creek. It has been sampled in 1992-95, 2000-04, 2009, and 2014. The fish populations in this reach did not change much as a result of the 2000 fires. Current numbers of westslope cutthroat trout are lower than past years. The number of bull trout captured has declined in recent years. Brook trout, brown trout, and rainbow trout are incidental and rare in the reach.
- **Warm Springs Creek 7.4:** This reach is located near the Sheeps Head Creek confluence. It was sampled in 1992, 1994-95, 2006-08, and 2014. In 2014, westslope cutthroat trout population numbers were lower than past estimates, while the number of bull trout was significantly lower than past estimates.
- **Waugh Creek 0.7:** This reach starts upstream of the Road 13334 culvert and is located inside of the 1997 riparian exclosure fence. It was sampled in 1990-91, 2001-05, and 2015. Westslope cutthroat trout are common in the reach and usually the only fish species present. In 2003, one brown trout was captured; in 1990-91, a few brook trout were captured. Only westslope cutthroat trout have been found in the reach since 2003. The westslope cutthroat trout population in 2015 was similar to past years.
- **West Fork Bitterroot River 1.2:** This reach is located between the Trapper Creek Job Corps Center and Conner. It was sampled in 1986, 1995,1997-98, 2002, 2007, 2011 and 2015. Since catch and release for cutthroat trout was initiated around 1991, the population of westslope cutthroat has increased. In 2015, the estimate of larger westslope cutthroat was higher than any past estimate. The rainbow trout population was lower than previous estimates. The brown trout population appears to be increasing over time.
- **Woods Creek 4.4:** This monitoring reach was established in upper Woods Creek a few weeks after high severity fire (2011 Saddle Complex Fire) burned the area. It was sampled in 2011, 2012, 2013, and 2014. The purpose of the reach is to monitor the post-fire recovery of fish populations in Woods Creek. The fire caused a large fish kill in the severely burned portion of Woods Creek. In 2011, a couple of months after the fire, only 16 westslope cutthroat trout and 4 bull trout were captured in two passes in the 1000 foot reach. In 2012, the number increased to 43 westslope and 15 bull trout. In 2013, it was much higher at 165 westslope and 50 bull trout. In 2011, all of the fish captured were > 5 inches in length. In 2012, a few 3-4 inch juveniles were captured, but most of the fish were > 5 inches. In 2013, young-of-the-year westslope and bull trout were common along the stream margins. On August 2, 2014, just a few days before our survey, the reach experienced a surge of muddy black water from a thunderstorm in the severely burned headwaters. The high water blew out a lot of the large wood, flattened the recovering riparian vegetation with mud, and filled the

pools with silt and mud. However, the event did not blow out the stream banks. Westslope cutthroat trout and bull trout numbers were down in 2014 as a result of this event (bull trout decreased from 50 fish to 21 fish; westslope decreased from 165 fish to 110 fish). It appears that the August 2014 high water event was a temporary set-back to the post-fire recovery of the westslope cutthroat trout and bull trout populations. No brook trout were found in 2011-14. A few bull trout X brook trout hybrids were captured in the reach in 2012, 2013, and 2014.

In addition to the population estimates described above, numerous presence/absence electrofishing and snorkel surveys were conducted across all districts of the Forest in 2014 and 2015. Species presence/absence and relative abundance levels are recorded in a Forest-wide database that is maintained by MFWP biologists in Hamilton. Forest-wide presence/absence of bull trout and westslope cutthroat trout has also been mapped on GIS. A few notable presence/absence electrofishing projects that were conducted in 2014 and 2015 are described below in greater detail.

Camp Creek Longitudinal Fish Presence/Absence Surveys

Since the Camp Creek 2.3 fish population monitoring reach has experienced a significant increase in the number of brown trout captured in the reach, we sampled upstream areas of Camp Creek in 2012, 2013, and 2014. Single pass electrofishing surveys were conducted at stream miles 4.2, 5.1, 5.7 and 6.6. In 2012 and 2013, one brown trout was captured at stream mile 4.2, and none were captured upstream of stream mile 4.2. In 2014, no brown trout were captured at stream miles 4.2 and 5.7, and stream miles 5.1 and 6.6 were not sampled. Culvert barriers on private land near stream mile 4.2 may be restricting the upstream expansion of brown trout in Camp Creek.

Sleeping Child Creek Longitudinal Fish Presence/Absence Surveys

Since the Sleeping Child Creek 10.2 fish population monitoring reach has experienced a significant increase in the number of brown trout, we sampled upstream in 2012, 2013, and 2014 (Table 3). Single pass electrofishing surveys were conducted at stream miles 11.0, 12.0, 13.0, 14.5 and at stream mile 0.1 in Divide Creek in 2012, 2013, and 2014. Brown trout were captured in Sleeping Child Creek as far upstream as stream mile 13.0. Brown trout have not been captured at the confluence of Sleeping Child and Divide creeks, which is at stream mile 14.5. Brown trout have not been captured in Divide Creek.

Table 3 - The Number of Brown Trout Captured in Single Pass Electofishing Sections of Sleeping Child Creek and Divide Creek in 2012, 2013, and 2014

Stream Mile (length in feet)	2012	2013	2014
Sleeping Child Creek 11.0 (300’)	Not sampled	7	5
Sleeping Child Creek 12.0 (351’)	4	Not sampled	4
Sleeping Child Creek 13.0 (300’)	2	7	2
Sleeping Child Creek 14.5 (340’)	0	0	0
Divide Creek 0.1 (330’)	0	0	0

Key Findings of the Forest’s Fish Population Monitoring

- Westslope cutthroat trout populations across the Forest appear to be stable and strong in most streams, but declined were observed in some of the reaches that were sampled in 2014 and 2015 (Figure 3). Westslope cutthroat trout are present in nearly every fish-bearing reach on the Forest, and are easily the most common species. At this time, there is no evidence that climate-driven water temperature increases are causing declines in westslope cutthroat trout populations.
- Bull trout populations are declining in most of the Forest’s core area streams (Figure 3). The declines first became evident around 2006. The sharpest declines have occurred in the East Fork Bitterroot River and

Warm Springs Creek. Both of these streams rely on migratory bull trout to maintain production and recruitment, and the number of migratory bull trout in the East Fork drainage has declined in our samples since 2000. Water temperatures have been increasing in Forest streams since 1993 due to climatic warming. Climate models predict that bull trout distribution on the Forest will shrink, with the lowest elevations losing their bull trout first. Eby et al. (2014) found evidence that since the mid 1990's, bull trout have abandoned some of their lower elevation habitats in the East Fork Bitterroot River watershed. *Eby, L.A., O. Helmy, L.M. Holsinger, and M.K. Young. 2014. Evidence of Climate-Induced Range Contractions in Bull Trout, Salvelinus confluentus in a Rocky Mountain Watershed, U.S.A. PLoS ONE 9(6): e98812. Doi:10.1371/journal.pone.0098812*

- Brown trout have increased their numbers and distributions in the East Fork Bitterroot River, the West Fork Bitterroot River below Painted Rocks Dam, in Sleeping Child Creek, and in the lower ends of some of the warmer tributaries to the East Fork such as Camp and Cameron Creeks. The expansion of brown trout is occurring at the same time (and often in the same places) that bull trout populations are declining. Warmer water temperatures are thought to be an important factor driving the brown trout expansion and the bull trout decline.
- For the past couple of decades, Forest and FWP biologists have considered brook trout to be the biggest non-native fish threat to bull trout. In recent years, however, our thinking has changed somewhat. Brown trout have increased their numbers and distribution in several streams in recent years, and may pose more of a long-term threat to bull trout than brook trout do. Warmer water caused by climatic warming is expected to favor brown trout over bull trout. In many streams where they occur together with native trout, brook trout do not appear to be expanding their numbers or distribution.
- Fifteen years after the 2000 fires, westslope cutthroat trout populations continue to be healthy and robust in the streams that were burned at high or moderate severity. The bull trout story is a mixed bag. The bull trout populations in Skalkaho and Daly creeks are similar to their pre-fire abundance levels, but gradual declines have been observed in Meadow Creek, and sharp declines have occurred in the Sleeping Child and Warm Springs Creek populations. Furthermore, the bull trout population in upper Rye Creek appears to have been extirpated since the 2000 fires. The bull trout populations in Laird, Little Blue Joint, and Chicken creeks are too small and incidental to distinguish trends. In 2016, Forest and FWP biologist plan on initiating bull trout presence/absence testing using eDNA technology.
- Most of the brook trout populations in the streams burned at high or moderate severity in 2000 still have not recovered to their pre-fire abundance levels. A few of the brook trout populations (Praine Creek, Little Blue Joint Creek) regained their pre-fire abundance level a few years ago.

Mountain Lake Surveys

Forest fisheries biologists surveyed two mountain lakes in 2014, Bass Lake and Fool Hen Lake, both of which are located on the Stevensville Ranger District. Tables 4 and 5 summarize the physical and biological data collected in the surveys of Bass and Fool Hen Lakes.

Table 4 - Summary of Physical Data Collected during Mountain Lake Surveys

Lake	Acres[1]	Elev (ft)[2]	Max. Depth (ft)	Secchi Depth (ft)	Temp. at Surface (°F)	Temp. at Shoreline (°F)	Temp. at 5 ft (°F)	Temp. at Max Depth (°F)
Bass	36	7140	51	30.5	61.7 @ 1330	n/m	n/m	48.6 @ 35 ft
Fool Hen	4	7452	22	n/m	n/m	n/m	n/m	n/m

[1]From NAIP2009Imagery, with ArcMap10. n/m = not measured.

Table 5 - Summary of Biological Data Collected during Mountain Lake Surveys

Lake	Fish Present	Catch per Angler Hour	Most Recent Fish Stocking	Trout Life Stages Observed or Limiting Factors	Amphibians in or Near Lake
Bass	Westslope cutthroat trout	4.2 fish/Angler Hr., 21 fish in 5 hrs; Range 6 - 12"	2009 Westslope cutthroat trout	Primary inlet stream may contain limited amount of spawning habitat. Did not see juvenile fish. Adults common.	Columbia spotted frog adults common
Fool Hen	Westslope cutthroat trout	8 hours of angling captured no fish	1990 Westslope cutthroat trout	Saw a few juvenile and smaller adult westslope cutthroat trout. Saw a few dead larger adults. Did not see spawning trout in the inlets or outlets in 2014.	None observed

Bass Lake (Stevensville Ranger District): Bass Lake was surveyed on July 29-30, 2014. Access via the Bass Creek trail took four hours with full backpacks. Catch rate was high (21 trout in 5 hours = 4.2 fish per hour). The trout species in the lake appeared to be westslope cutthroat trout, and that is the species that was most recently stocked in 2009. Previous stockings of westslope cutthroat trout also occurred in 2002 and 1984. There was some question whether some of the westslope caught in 2014 were hybridized with rainbow trout. The last documented stockings of rainbow trout occurred in 1967 and 1978. Successful spawning by trout may be possible in or near the primary inlet to Bass Lake, but was not confirmed. The size range of the westslope cutthroat trout that were observed was 6 to 12 inches.

The trout in Bass Lake were robust in shape relative to some other Bitterroot high mountain lakes such as Chaffin Lake (of Chaffin Creek) and Peterson Lake (of Sweeney Creek). Reservoir water was being released from Bass Dam during the survey; the level of the lake dropped approximately three inches in 12 hours. One bald eagle was perched near the lake, and pikas were common and photographed.

The only surface water inlets found were at the far upstream end of the lake (southern end). The dam outlet is a boulder spillway and a pipe; neither provides upstream access from the outlet stream back into the lake. There was no water flowing out the spillway during our visit. There were areas throughout the downstream side of the dam that water flowed from the riprap and to the outlet channel. It was a very leaky dam, but the water leaking through the dam was clear and not carrying fine sediment.

Bass Lake was very clear. Secchi depth measured by a swimmer was 30.5 feet. The deepest point found was 51 feet, but only the east half of the lake was thoroughly sounded. The surface temperature at 1330 on July 29 was 61.7° F.

Fool Hen Lake (Stevensville Ranger District): In spring 2014, a fish die-off was reported to Forest fisheries biologists from Chris Clancy (MFWP fisheries biologist), who got information from a concerned citizen.

A survey of the lake in 2008 reported that fish were easily observable from shore, including cutthroat trout spawning in two inlets and the outlet of the lake in early July. Angling was conducted in 2008 and the catch rate was approximately 1 fish per hour.

Fool Hen Lake was visited by Robert Brassfield, North Zone Bitterroot fish biologist, and a student intern on July 1, 2014. They observed:

- One live trout about eight inches long darting between floating logs along the shoreline.
- Four dead fish were seen in the lake. Three of them were 12 inches long; the fourth was 16 inches long.
- Four hours of angling resulted in no observations of fish.
- Noted that the lake seemed less clear than most Bitterroot NF lakes.
- No signs of spawning fish in the inlets or outlet.
- Gammarus and other aquatic invertebrates more numerous in deep water than in 2008.

A second visit of Fool Hen Lake occurred on July 16, 2014, this time by Nathan Olson (Forest fisheries technician) and Breanne Huckabone (water rights student intern from the USFS Region One office). They observed:

- Five live trout ranging from 3 to 8 inches long.
- Five old dead fish within the lake.
- Noted a slight fishy odor near the lake similar to the smell of the Pacific NW coast.
- Spoke to a fly-fisherman who fished for a couple hours and saw no fish or signs of live fish.
- No signs of spawning fish in the inlets or outlet.
- Angling resulted in seeing some fish (they would follow the lure), but no fish were caught.

It appears that late winter or spring conditions in Fool Hen Lake resulted in the death of the larger fish in the lake (winter kill), but some portion of the smaller fish survived. Although it may be coincidental, the late winter/spring of 2014 had deeper snow accumulation than most of the winters in the previous decade. Fool Hen Lake is a shallow (max depth 22 feet) mountain lake, which could render it vulnerable to light attenuation by snow and ice and eventual oxygen depletion.

VIABILITY OF BULL TROUT AND WESTSLOPE CUTTHROAT TROUT POPULATIONS:

The Forest Plan defined a fish population viability concern as a decline in aquatic habitat quality and/or fish population for more than one year (Item 21), and a 10 percent difference from projected cutthroat trout yield (Item 41). Research and monitoring of fish populations over the two decades on the Forest has shown the Forest Plan viability stated above is too narrow given the natural variation that occurs in fish populations. We have learned that the only way to define the upper and lower bounds of the natural variation in fish populations is through numerous years of population monitoring.

In 2014 and 2015, Forest and MFWP biologists sampled 29 fish population monitoring reaches where enough westslope cutthroat trout were captured to calculate a statistically-valid population estimate and there were enough years of population estimates to consider the site “long-term”. Westslope cutthroat trout numbers were up by more than 10% of the long-term average in 12 reaches, within 10% of the long-term average in 10 reaches, and down by more than 10% of the long-term average in 7 reaches (Figure 5). Of the 20 reaches that were sampled in 2014-15 that had an estimable bull trout population or a long term data set that allowed comparison of catch per unit effort, bull trout population trends were positive in 1 reach, neutral in 1 reach and negative (declining) in 18 of the reaches (Figure 5).

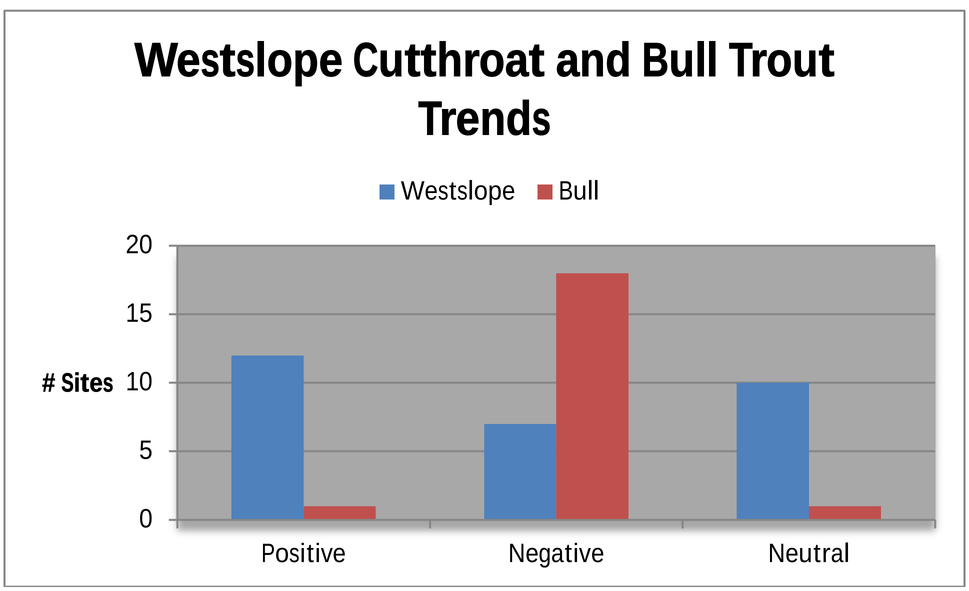

Figure 5– Bull Trout and Westslope Cutthroat Trout Population Trends on or near the Bitterroot National Forest in 2014 and 2015

Westslope cutthroat trout populations are believed to be stable in most of the streams on the Forest, and the data in Figure 5 is generally supportive of that belief. Populations do fluctuate naturally over time, but the body of our monitoring data indicates a stable trend Forest-wide. An estimated 63% of the westslope cutthroat populations that have been tested on the Forest are genetically unaltered. Despite the presence of healthy populations in most Forest tributaries, the overall viability of westslope cutthroat trout in the Bitterroot River basin is considered to be “depressed”, primarily because of the habitat fragmentation that occurs on private land between the Bitterroot River and its tributaries, and the reduced numbers of migratory adult fish in the river. A key problem is the lack of year-round connectivity between the Bitterroot River and its spawning and rearing tributaries on the east and west sides of the valley. Considerable efforts and funds were expended to screen irrigation ditches, eliminate fish passage barriers, and secure instream flows in Skalkaho Creek, a key spawning and rearing tributary near Hamilton. Monitoring data collected since the installation of three fish screens and two siphons indicates that the response by the westslope cutthroat trout population has been less than hoped for.

Bull trout populations are declining in most streams on the Forest. At best, bull trout population trends may be neutral in a few of the stronghold streams such as Skalkaho and Daly creeks. Along with the decline in bull trout has been a concurrent expansion of brown trout populations. Since about 2000, brown trout populations have expanded their numbers and distributions in the East Fork Bitterroot River, West Fork Bitterroot River, Sleeping Child Creek, and Camp Creek. Pioneering brown trout individuals were also found in several tributaries to the East and West Forks for the first time in recent years (e.g. Meadow Creek in 2003 and 2013, Praine Creek in 2011). The nature of interaction between brown trout and bull trout is complex. Bull trout are declining at the same time that brown trout are expanding, but the evidence does not indicate that displacement is the mechanism driving the changes.

WATER TEMPERATURE MONITORING:

The Forest Plan does not contain water temperature monitoring requirements, but water temperature is a Riparian Management Objective in INFISH (1995). Nevertheless, since 1993 the Bitterroot National Forest and the MFWP have cooperatively developed an extensive system of water temperature monitoring sites in streams across the Forest. Figure 6 displays the number of sites that have been monitored since 1993.

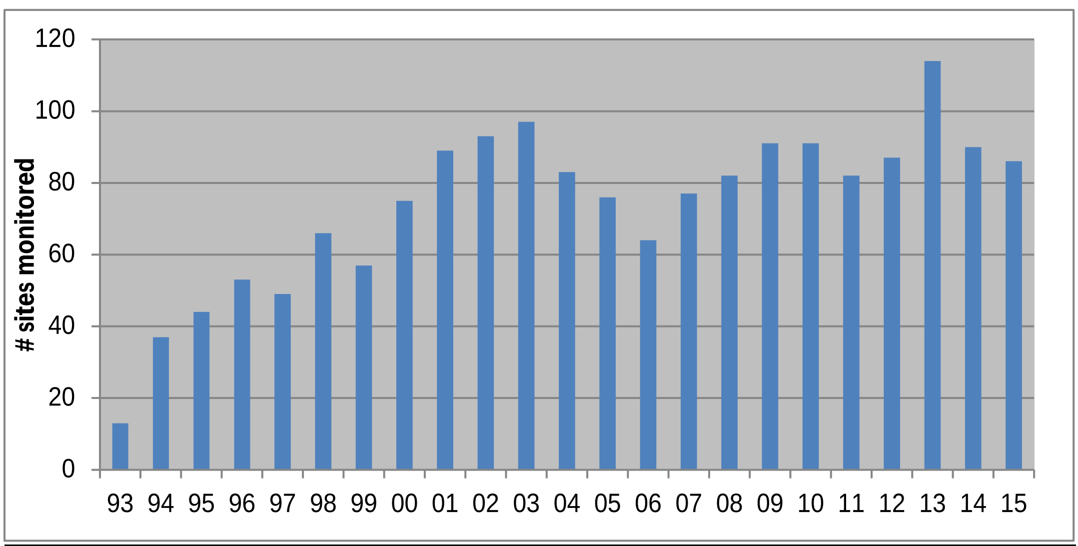

Figure 6 - Number of Water Temperature Monitoring Sites on the Bitterroot National Forest

On the Forest, we have established an annual temperature monitoring period that starts on July 18th and ends on October 1st. This 76-day monitoring period usually captures the warmest part of the year, and is the part of the year where water temperatures probably have their greatest influence on native salmonids.

The unit of measure used to compare sites is the degree-day. Degree-days are calculated by summing the mean daily temperature that occurs at each site for every day between July 18th and October 1st (a 76-day monitoring period). For example, summing the 76 mean daily temperatures that occur at a given site between July 18th and October 1st gives you the total number of degree-days that were accumulated at that site. The higher the number of degree-days, the warmer the site. Degree-days are a useful variable because they standardize temperature data and allow comparisons between different years and different size streams.

There is a correlation between summer air temperatures and water temperatures, and this affects the number of degree-days. For example, during hot summers like 2003, most of the monitoring sites on the Forest set their all-time highs for degree-days. During cold summers like 1993, most of the sites set their all-time lows. Because the weather causes a lot of the variation in the degree-days at a given site from year to year, the Forest has established a network of index monitoring sites to reduce some of that variability. Index sites are unburned reference sites that are monitored every year. They function as control sites. By comparing the degree-day trends in the burned and/or managed sites against the degree-day trends in the unburned and/or unmanaged index sites, we can reduce the variability caused by the weather and make some inferences about the influence of the fires and/or management activities on stream temperatures.

Figure 7 displays how mean summer (July-September) air temperatures have varied from the 30-year (1960-1990) mean at the Stevensville Ranger Station weather station since 1993. The 30-year period used for reference is 1960-1990. The mean air temperature for the 1960-1990 period is represented by the “0” horizontal line in the graph. Each bar represents the sum of the deviations from the 30-year mean air temperature for the months of July, August, and September. The bars near the “0” line are the years where the July-September air temperatures were very close to the 30 year average. The bars above the “0” line are the years where the July-September air temperatures were warmer than average. The bars below the “0” line are the years where the July-September air temperatures were colder than average.

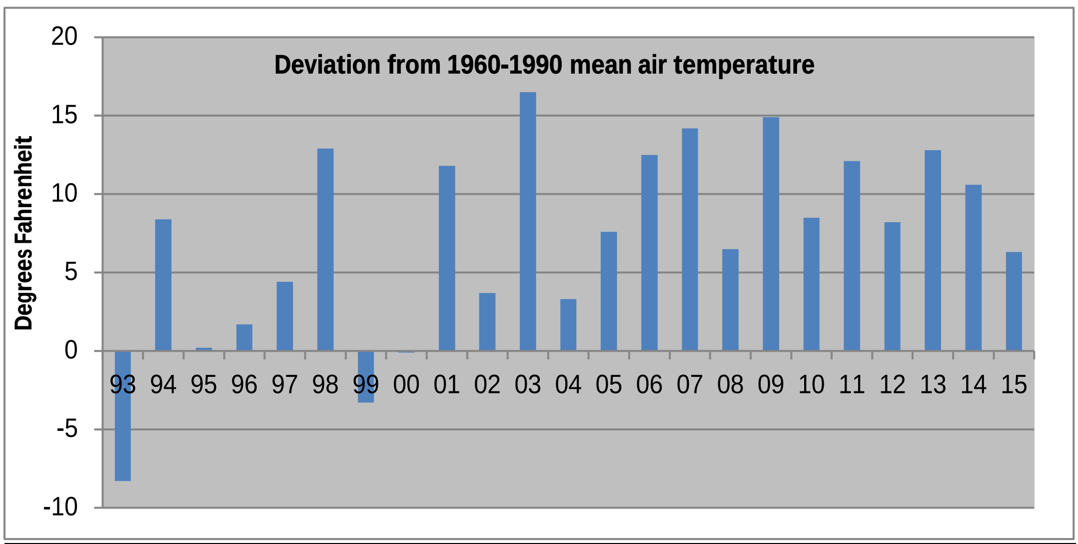

Figure 7 – Deviation in Mean Summer (July-September) Air Temperatures from the 30-Year (1960-1990) Mean Recorded at the Stevensville Ranger Station Weather Station

Summers 2014 and 2015 were the 10th and 11th consecutive warmer than average summers on the Bitterroot National Forest. The last summer that had average temperatures was 2004. The last summer that was colder than average was 1993.

The trend in air temperatures over the past 20+ years (Figure 7) indicates that summers are getting warmer on the Bitterroot National Forest. The frequency of hot days (> 90º F) is increasing, and the seasonal window in which those days can occur is widening. These trends are similar to those reported by Pederson et al. (2010).

Pederson, G.T., L.J. Graumlich, D.B. Fagre, T. Kipfer, and C.C. Muhlfeld. 2010. A century of climate and ecosystem change in Western Montana: what do temperature trends portend? Climate Change (2010) 98:133-154.

Figure 8 displays by month, how the mean air temperatures for July, August, and September have varied from the 30-year mean at the Stevensville Ranger Station weather station since 1993. There is considerable variability from year to year and from month to month; however, the overall trend is for increasing temperatures in all three months.

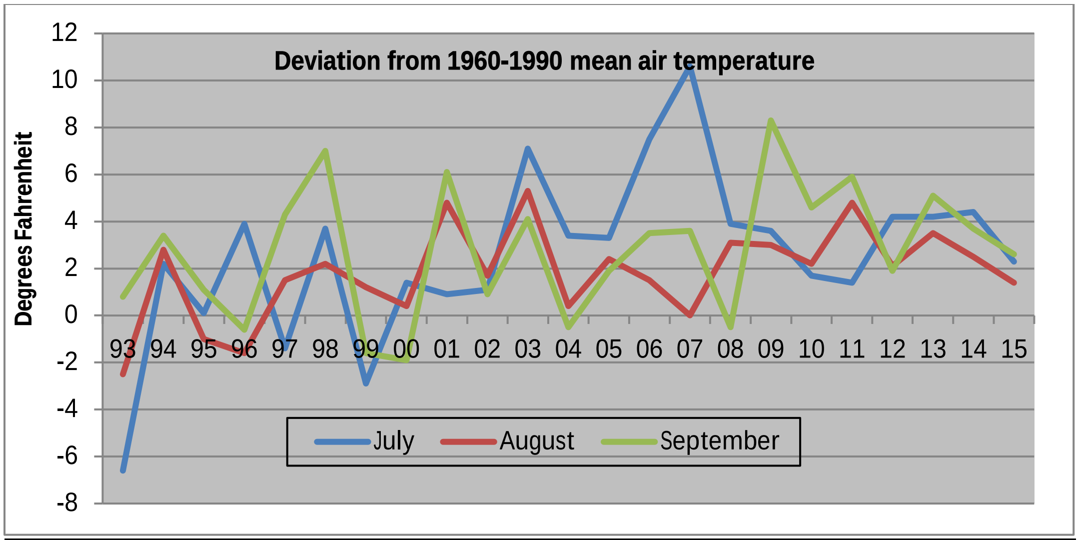

Figure 8 – Comparison of July, August, and September Mean Air Temperature Deviations from Their 30-Year (1960-1990) Mean at the Stevensville Ranger Station Weather Station

2014 was a warmer than average summer in the Bitterroot basin. However, the winter snowpack leading into the summer was one of the biggest in the past 20 years (158% of median on April 1st), and this surplus of snow allowed stream flows to remain above average throughout much of the summer and buffered stream temperatures from the warm air temperatures. Peak flow on the Bitterroot River at Darby occurred on May 24, 2014. The peak was 7.84 feet, and river flows at the Darby gauge exceeded the bankfull stage for about a week.

Of the 90 sites that were monitored in 2014 (Figure 6), 86 had degree day readings that were neither their warmest nor coldest on record. Of the sites that had at least three years previous data, only one had its warmest reading (Warm Springs Creek 7.4), while three had their coldest readings (Deer Creek 0.1, Lost Horse Creek 5.4, and Mitchell Slough at Victor Crossing).

The 2015 water year was an interesting contrast to water year 2014. Summer air temperatures in 2015, although still warmer-than-average (Figure 7), were cooler than those of summer 2014 (Figure 8). This cooling, however, did not translate into cooler stream temperatures. At nearly all of the monitoring sites, stream temperatures in 2015 were warmer than those of 2014. The warmer stream temperatures in 2015 were the result of lower stream flows. The El Nino snowpack that accumulated during the winter of 2014-15 was only 78% of median on April 1st, and it melted off early. The low snowpack and early snow melt resulted in low stream flows throughout July-September. Peak flow on the Bitterroot River at Darby occurred on May 17, 2015. The peak was 5.32 feet, and river flows never even approached within two feet of the bankfull stage.

Of the 86 sites that were monitored in 2015 (Figure 6), 82 had degree day readings that were neither their warmest nor coldest on record. Of the sites that had at least three years previous data, two sites had their warmest readings (Blodgett Creek 0.1 and North Rye Creek 1.9), while two sites had their coldest readings (Mine Creek 0.2 and Praine Creek 1.0).

In 2014 and 2015, the emphasis of our water temperature monitoring consisted of a mix of long-term index site monitoring, TMDL monitoring, project monitoring, and post-fire monitoring (2000 fires). Our results are discussed below.

INDEX SITE MONITORING:

Index sites are unburned or lightly burned reference sites that are monitored every year. They function as control sites, and allow us to sort out some of the year-to-year variability that occurs as a result of weather. In the early 1990's, as computerized thermographs became commercially inexpensive and available, Forest and FWP fisheries biologists established a network of 13 index sites on the Montana portion of the Bitterroot National Forest and six index sites on the Idaho portion of the Forest. A few of the index sites (e.g. Rye Creek 12.4 and Tolan Creek 5.1) were significantly burned during the 2000 fires, and probably do not function as good references for the time being.

In 2014 and 2015, we monitored temperatures at 17 and 16 index sites, respectively. Eleven (2014) and 12 (2015) of the sites were located on the Montana portion of the Forest; six of the sites were located on the Idaho portion of the Forest. None of the index sites set their warmest or coldest degree day records in 2014 and 2015. In 2015, all but two (Rye 12.4 and Sleeping Child 10.2) of the index sites were warmer than in 2014 (Figure 9).

Figure 9 plots the degree days that have been recorded at the Montana index sites since 1993. The key thing to notice in Figure 9 is the overall rising pattern of the data points – this indicates that the index streams have been warming over the past 20+ years.

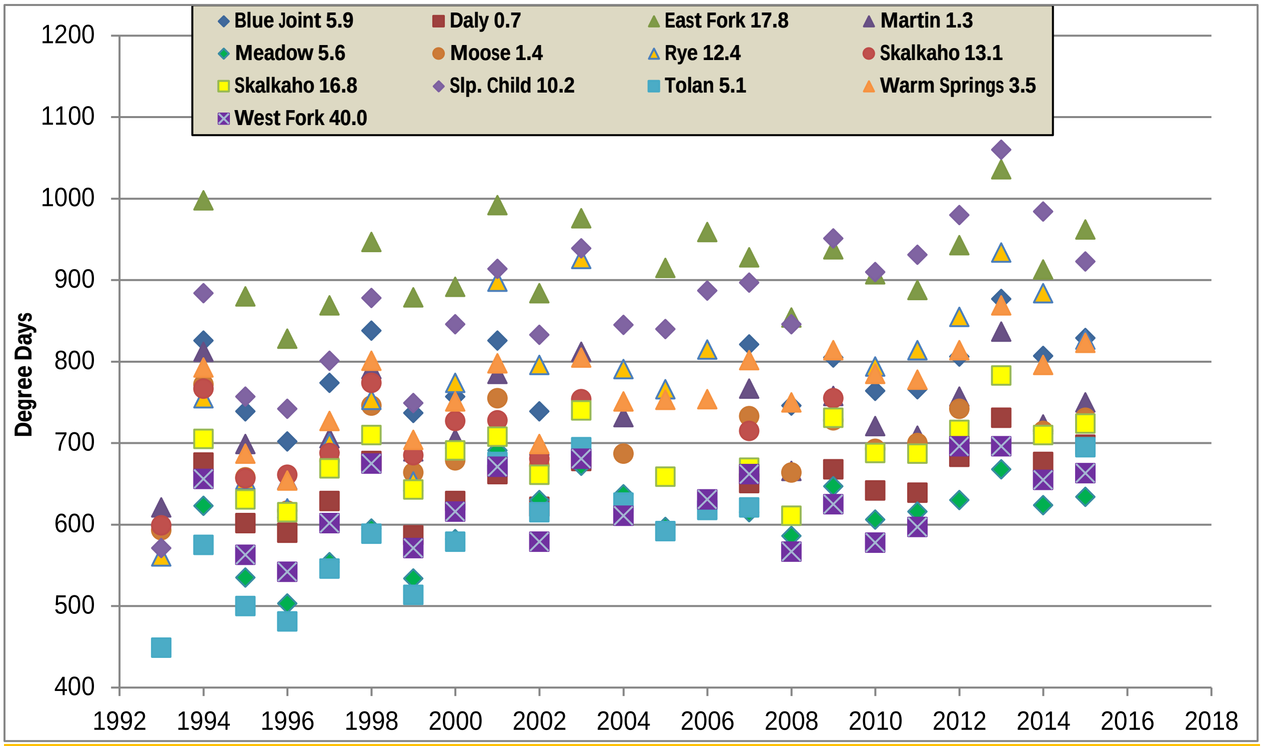

Figure 9 – Degree days Recorded at the Montana Index Sites Since 1993

TMDL MONITORING:

The Bitterroot Headwaters TMDL designated five water bodies as thermally impaired (East Fork Bitterroot River; West Fork Bitterroot River; Hughes Creek; Overwhich Creek; and the Nez Perce Fork). In the TMDL Monitoring Plan, a total of 12 sites were assigned for water temperature monitoring in those five streams, with specific water temperature goals for each site. Table 6 lists the thermally impaired water bodies in the Headwaters TMDL, their specific monitoring sites and temperature goals, and how the 2014 and 2015 temperatures compared to the goals. Only one of the sites met its TMDL temperature goal in 2014 or 2015, and that was the Hughes Creek 9.0 site in 2015. The West Fork 40.0 site came close to meeting its goal in both years.

Table 6 - Bitterroot Headwaters TMDL Water Temperature Monitoring Results

Thermally Impaired Streams	TMDL Monitoring Sites	TMDL Goal (warmest 7-day mean-maximum temp)	2014 Temperature (warmest 7-day mean-maximum temp)	2015 Temperature (warmest 7-day mean-maximum temp)
East Fork Bitterroot River	River mile 0.5	< 15.0° C	19.9° C	22.5° C
	River mile 17.8	< 15.0° C	18.0° C	19.9° C
	River mile 31.4	< 12.0° C	15.2° C	17.0° C

Thermally Impaired Streams	TMDL Monitoring Sites	TMDL Goal (warmest 7-day mean-maximum temp)	2014 Temperature (warmest 7-day mean-maximum temp)	2015 Temperature (warmest 7-day mean-maximum temp)
West Fork Bitterroot River	River mile 1.2	< 15.0° C	18.4° C	20.6° C
	River mile 22.2	< 15.0° C	16.2° C	16.1° C
	River mile 40.0	< 12.0° C	12.1° C	12.4° C
Hughes Creek	Stream mile 1.4	< 15.0° C	15.8° C	17.0° C
	Stream mile 9.0	< 15.0° C	15.4° C	14.1° C
Overwhich Creek	Stream mile 2.0	< 15.0° C	16.4° C	18.4° C
	Stream mile 7.0	< 12.0° C	15.2° C	16.0° C
Nez Perce Fork	Stream mile 1.0	< 15.0° C	16.9° C	18.7° C
	Stream mile 11.0	< 12.0° C	14.2° C	15.6° C

Figure 10 displays the trend in mean-maximum temperatures at the eight Headwaters TMDL monitoring sites that have a temperature goal of < 15° C.

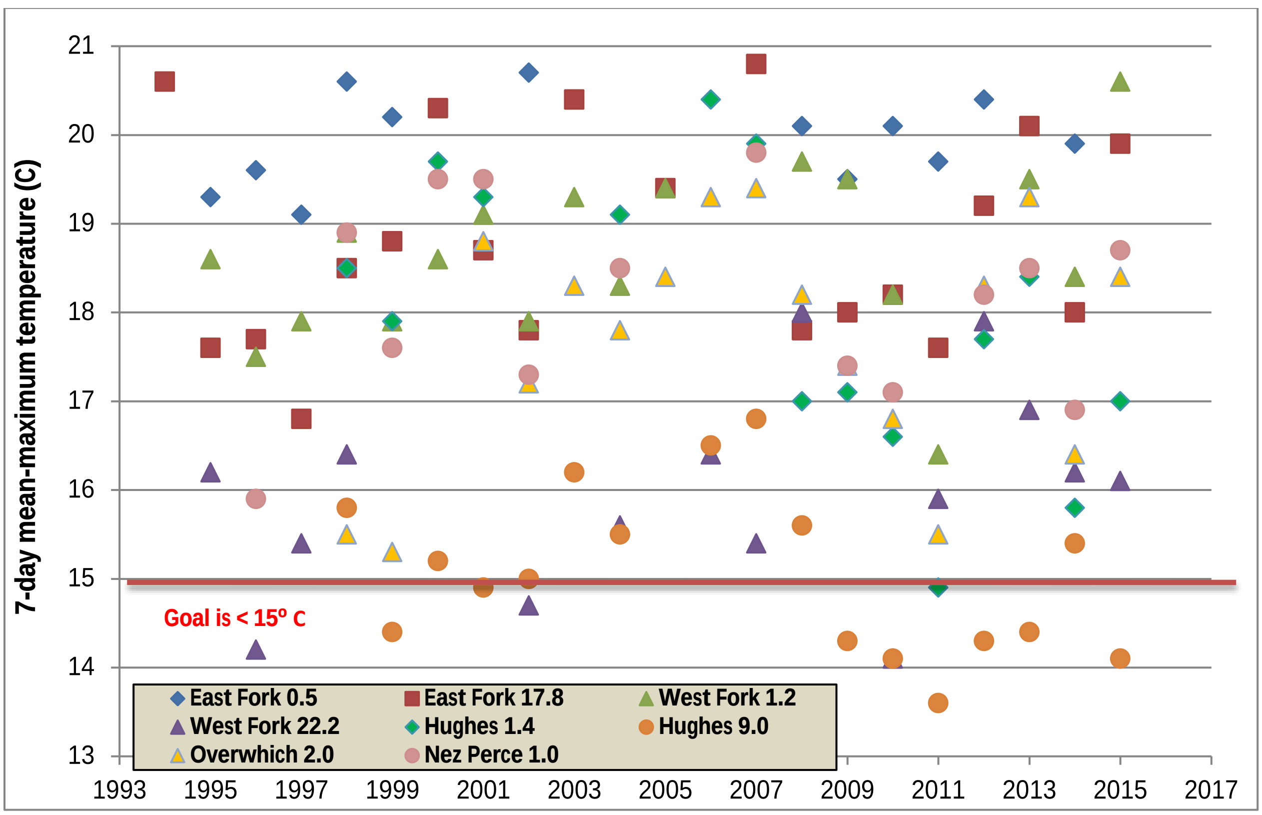

Figure 10 – Mean-Maximum Temperatures at the Eight Headwaters TMDL Monitoring Sites with a Temperature Goal of < 15° C

The data points in Figure 10 show that of the eight monitoring sites with a < 15° C TMDL goal, only the Hughes Creek 9.0 site has been able to meet the goal about half the time. The rest of the sites consistently exceed the goal. The West Fork 22.2 site, which is located directly downstream of Painted Rocks Dam, met its goal a couple of times in the early 2000's, but has not met it since. At river mile 22.2, temperatures are strongly controlled by the timing of water releases from Painted Rocks Dam. The earlier in the summer the releases from the dam occur, the warmer the temperatures usually get at the river mile 22.2 site.

Figure11 displays the trend in mean-maximum temperatures at the four Headwaters TMDL monitoring sites that have a temperature goal of < 12° C.

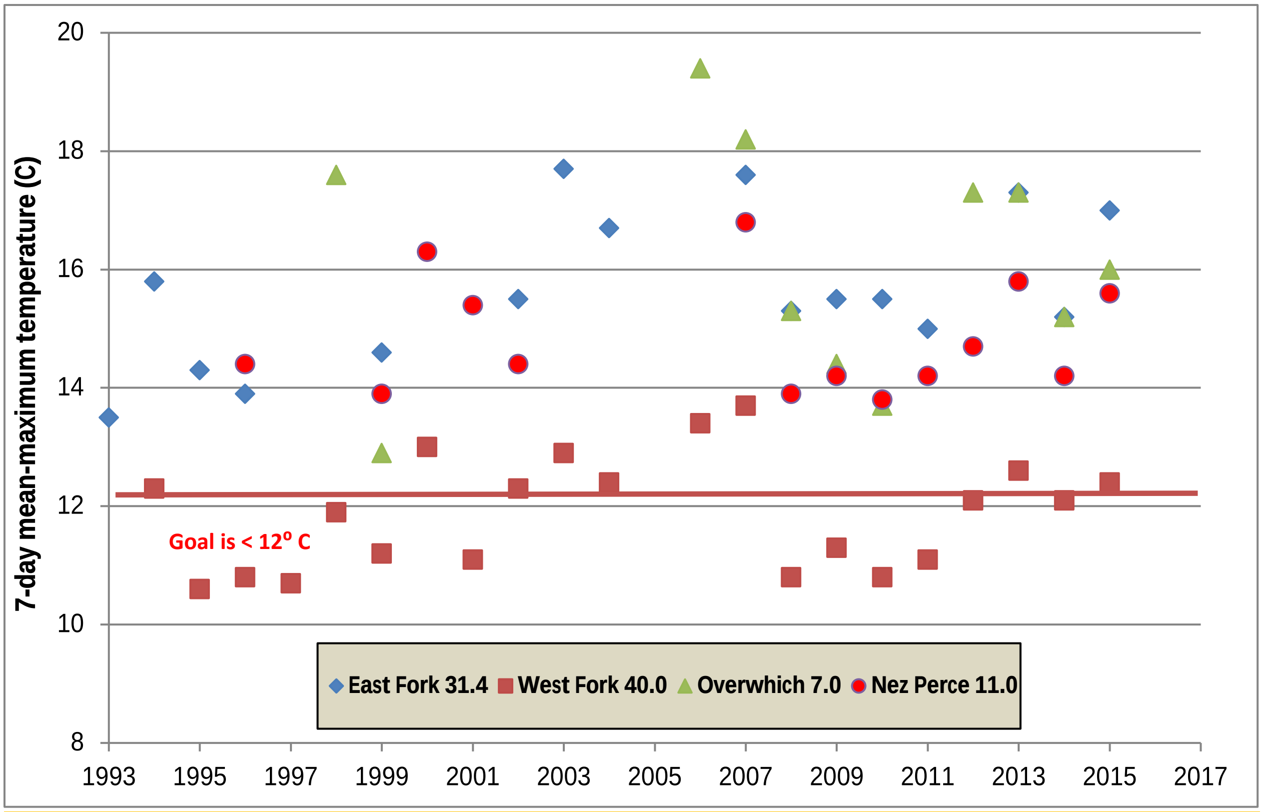

Figure 11 – Mean-Maximum Temperatures at the Four Headwaters TMDL Monitoring Sites with a Temperature Goal of < 12° C

The data points in Figure 11 show that of the four monitoring sites with a < 12° C TMDL goal, only the West Fork 40.0 site has been able to meet the goal in some years. The West Fork 40.0 site has warmed since the Saddle Complex Fire in 2011. None of the other sites have met the goal.

Figures 12-16 display the trend in degree days at the twelve Headwaters TMDL water temperature monitoring sites. Most of the sites show an increasing trend in degree days (Figures 12, 13, 15, and 16). The Hughes Creek sites (Figure 14) show a decreasing trend. The reason for the decreasing trend is unclear. It may be related to changes in mining activities on upstream private lands.

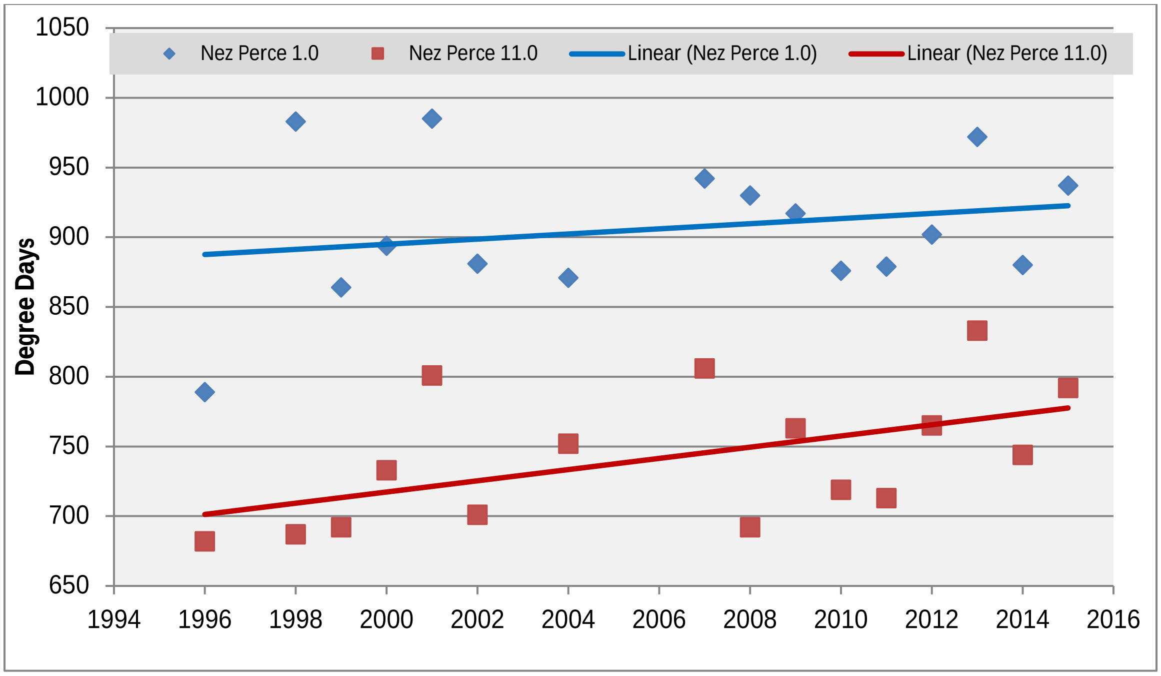

Figure 12 - Trend in Degree Days at the Nez Perce Fork River Mile 1.0 and River Mile 11.0 Water Temperature TMDL Monitoring Sites

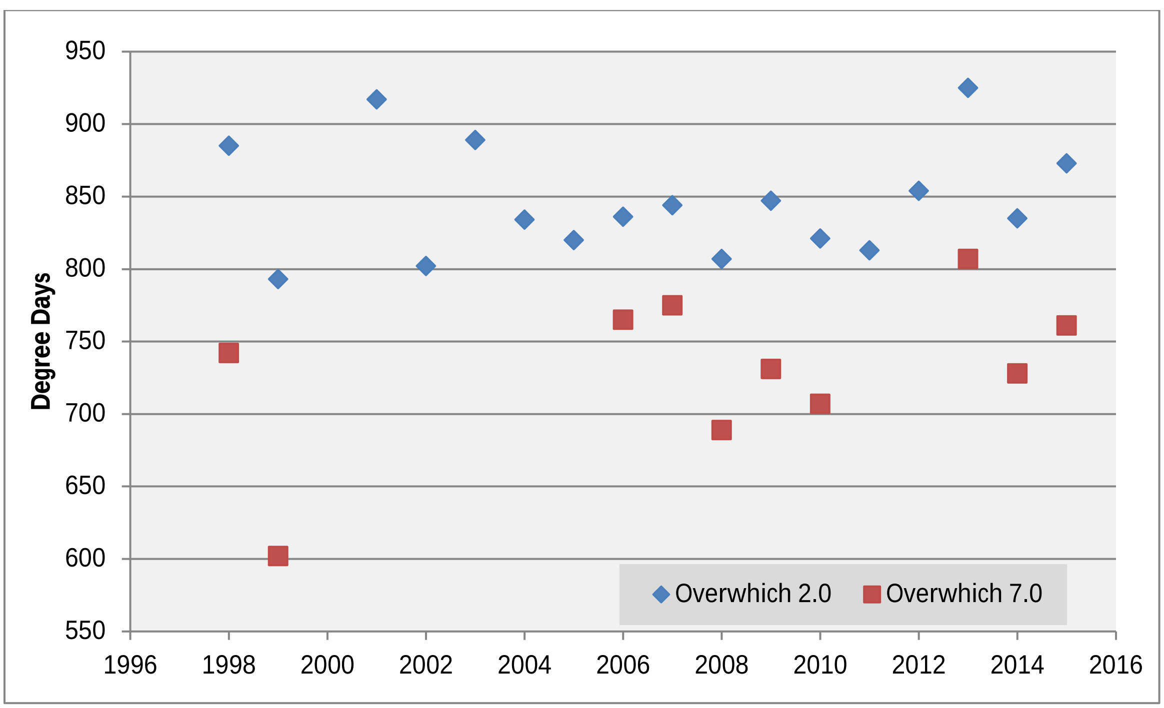

Figure 13 - Trend in Degree Days at the Overwhich Creek River Mile 2.0 and River Mile 7.0 Water Temperature TMDL Monitoring Sites

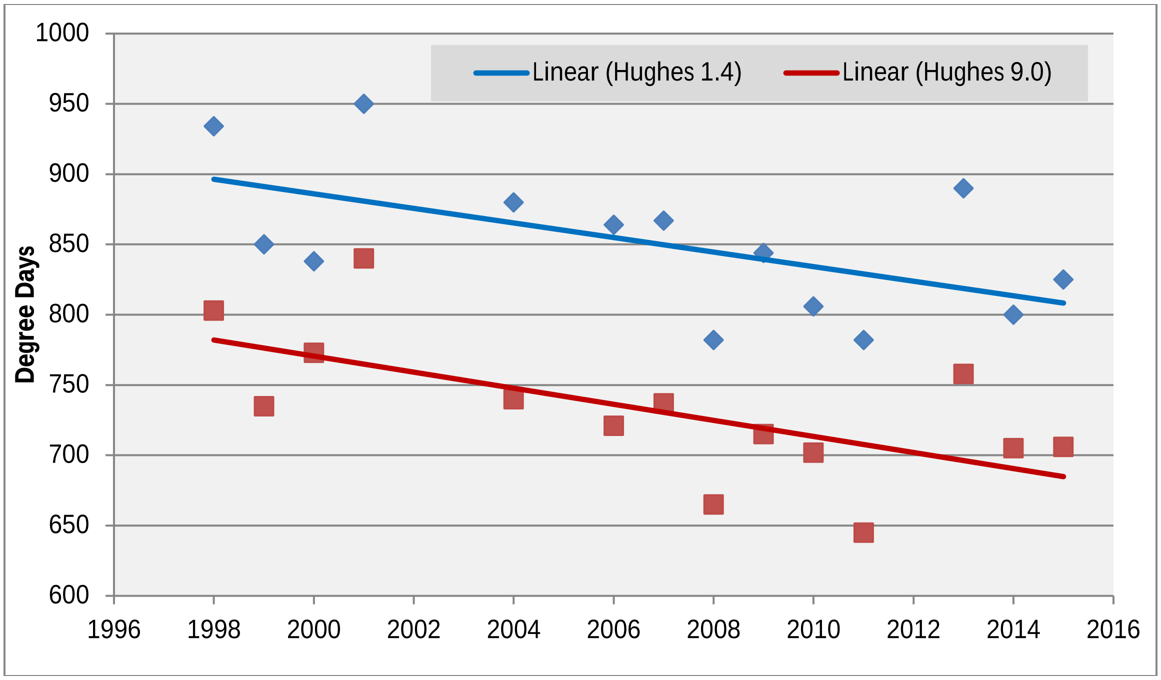

Figure 14 - Trend in Degree Days at the Hughes Creek River Mile 1.4 and River Mile 9.0 Water Temperature TMDL Monitoring Sites

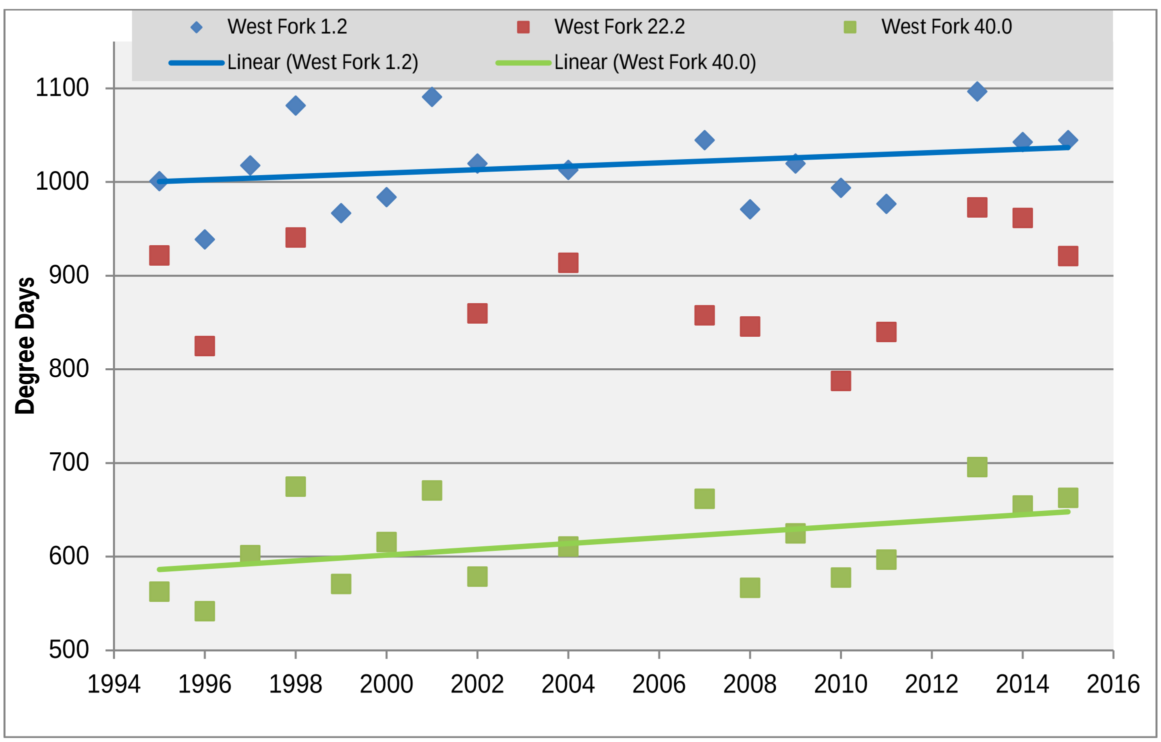

Figure 15 - Trend in Degree Days at the West Fork Bitterroot River Mile 1.2, River Mile 22.2, and River Mile 40.0 Water Temperature TMDL Monitoring Sites

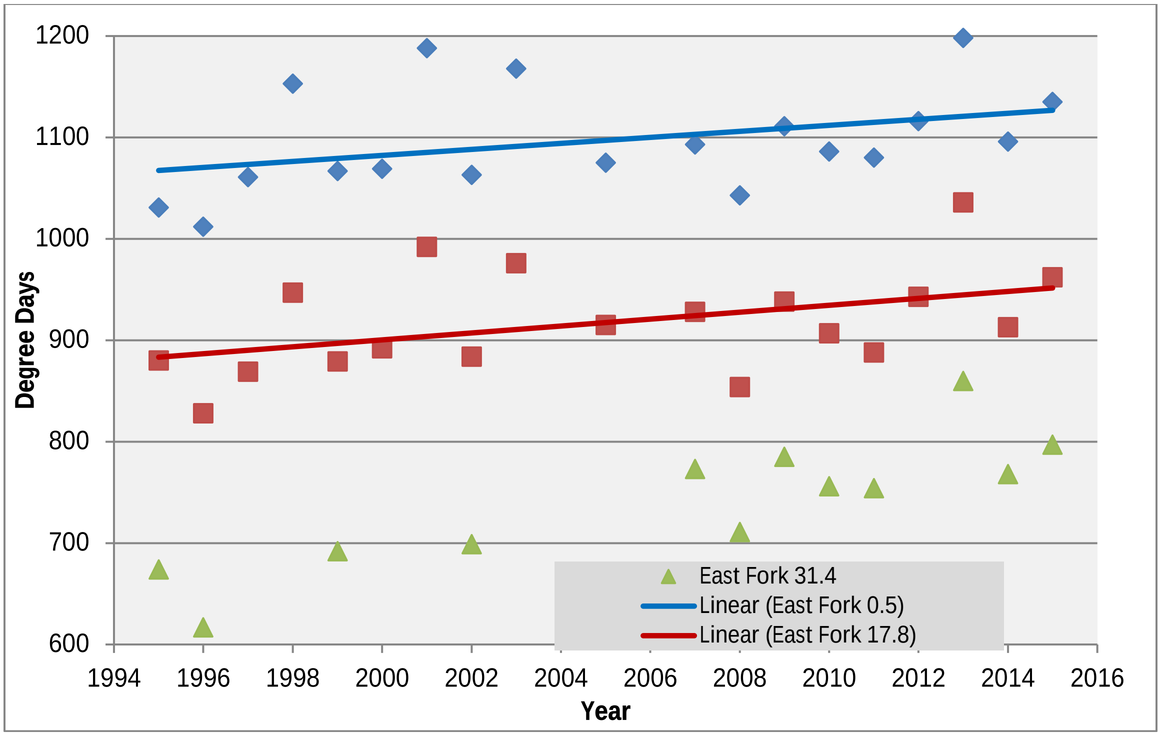

Figure 16 - Trend in Degree Days at the East Fork Bitterroot River Mile 0.5, River Mile 17.8, and River Mile 31.4 Water Temperature TMDL Monitoring Sites

PROJECT MONITORING:

<u>Lower West Fork EIS Timber Sale (West Fork Ranger District):</u> The Lower West Fork timber sale commenced in June, 2012 and was completed in April, 2013. The main prescription was commercial thinning, and the yarding systems were a mix of tractor and skyline. The RHCAs were protected from cutting and skidding. The haul road segments that encroach on Lavene Creek (Road 5630) and Pierce Creek (363) were a key concern in the sale, and those two streams were the focus of our water temperature monitoring efforts. All of the Lower West Fork harvest and hauling was completed by spring, 2013.

In the Lower West Fork EIS, we made a commitment to monitor water temperatures in Pierce Creek, Lavene Creek, Piquett Creek, and East Piquett Creek before (2001-06, 2009), during (2012) and after (2013-14) all of the timber harvest, prescribed burning, and log hauling was completed. Those streams were chosen for monitoring because they were the ones most likely to show any temperature changes resulting from the timber sale. As things turned out, timber harvest, pile burning, and log hauling only occurred in the Pierce and Lavene creek drainages; all of the timber harvest activities in the Piquett Creek drainage were dropped in the Lower West Fork Record of Decision. Therefore, we only monitored pre-harvest and post-harvest stream temperatures in Pierce and Lavene creeks.

Water temperature monitoring sites (i.e. treatment sites) were established in Pierce Creek (milepost 0.4) and Lavene Creek (milepost 0.1) where those streams exit the Forest. Two nearby reference sites (Baker Creek 1.1 and Christisen Creek 0.7) served as the control sites. Water temperatures were monitored in the treatment and control sites for seven years pre-harvest (2001-06, 2009), for one year during harvest (2012), and for two years post-harvest (2013 and 2014). In 2012, our older model thermographs filled up their memory capacity on August 26, 2012, so we were unable to get degree day readings for that year. As a result, we were unable to include the 2012 data in Figure 15.

Figure 17 displays the degree days that we measured at the two treatment sites (Pierce Creek 0.4 and Lavene Creek 0.1) and the two control sites (Baker Creek 1.1 and Christisen Creek 0.7) between 2001 and 2014. The degree days measured at the two control sites were averaged for each year and displayed as a single line in Figure 17.

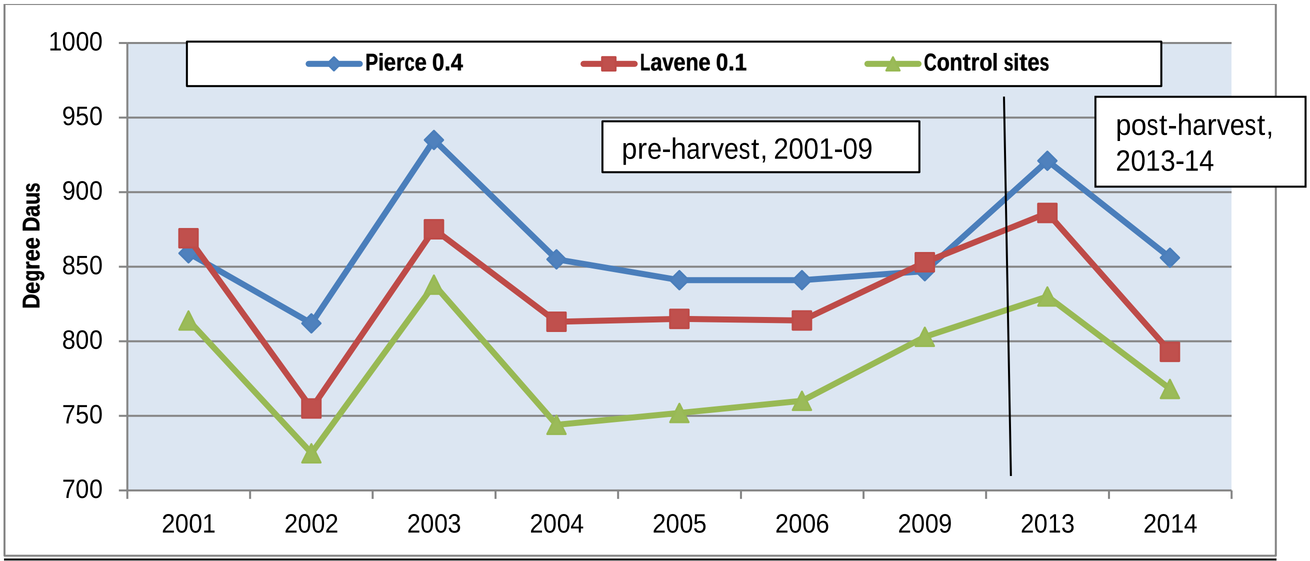

Figure 17 – Degree days Measured in the Two Treatment Sites (Pierce Creek 0.4 and Lavene Creek 0.1) and the Control Sites before (2001-06, 2009) and after (2013-14) the Lower West Fork Timber Sale

The Lower West Fork EIS predicted that timber harvest, prescribed burning, and log hauling would maintain the existing water temperature regimes in streams. The data in Figure 15 supports that prediction. The pattern of degree days in the treatment streams (Pierce and Lavene creeks) tracked the pattern of degree days in the control streams during both the pre-harvest (2001-06, 2009) and post-harvest (2013-14) periods. If Lower West Fork timber sale activities had increased temperatures in Pierce and Lavene creeks, the lines for those streams should have diverged further from the control stream line in 2013 and 2014. That did not occur. The pattern of the trend lines in the post-harvest years was similar to the pattern in the pre-harvest years. Our conclusion is that no discernible warming of Pierce and Lavene creek's stream temperatures has occurred as a result of Lower West Fork timber harvest, log hauling, and pile burning activities. This completes the monitoring commitment made for the timber harvest portion of the Lower West Fork EIS. If any Lower West Fork prescribed burning is conducted in the Piquett Creek drainage in future years, stream temperatures will be monitored in Piquett and East Piquett creeks.

POST-FIRE MONITORING:

2000 Fires (Sula and West Fork Ranger Districts): Mahlum et al. (2011) investigated the recovery of post-fire water temperatures on the Bitterroot National Forest seven years following the 2000 fires. Their findings were published in the *International Journal of Wildland Fire.* Mahlum et al. (2011) reported that starting one month after the 2000 fires and in the subsequent year, increases in maximum water temperatures at sites within burns were 1.4–2.28 ° C greater than those at unburned reference sites, with the greatest differences occurring in the months of July and August. Seven years after the fires (2007), there was no evidence that maximum stream temperatures were returning to their pre-fire norms. Mahlum et al. (2011) concluded that temperature increases in these relatively large streams are likely to be long-lasting and exacerbated by climate change.

On a related note, Forest fisheries biologists have monitored water temperatures in Laird Creek (milepost 1.5), Little Blue Joint Creek (milepost 1.5), and Cameron Creek (milepost 10.1) nearly every summer since the 2000 fires. These three sites were also included in the Mahlum et al. (2011) research. Figure 16 shows how the degree days in Laird, Little Blue Joint, and Cameron creeks have changed over the past 15 years relative to their unburned index sites. For Laird and Cameron creeks, the index sites used for comparison were Martin Creek (milepost 1.3) and Moose Creek (milepost 1.4). For Little Blue Joint Creek, the index site used for comparison was Blue Joint Creek (milepost 5.9). Pre-fire data points were available for Little Blue Joint (1995) and Cameron Creek (1999), but not for Laird Creek. In 2012, we deployed thermographs at Laird, Little Blue Joint, and Cameron Creek sites, but were only able to get a degree day reading from the Cameron Creek site because of thermograph malfunctions at the Laird and Little Blue Joint sites. In 2014, we did not monitor temperatures at the Cameron Creek site.

In Figure 18, the "0" line on the y-axis indicates that degree days at a burned site were identical to the degree days at its index site. Negative data points indicate the degree days at a burned site were less than (i.e. colder) than its index site. Positive data points indicate the degree days at a burned site were greater than (i.e. warmer) than its index site. If temperatures are recovering in the burned streams, their data points should approach the "0" line over time.

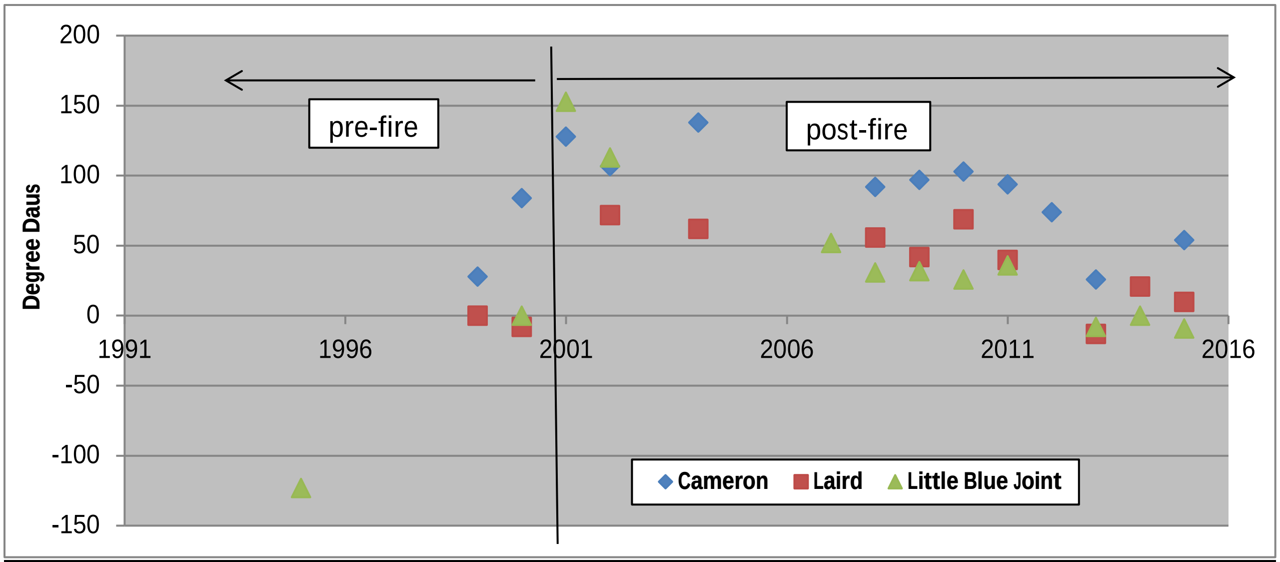

Figure 18 – Degree Day Differences between Laird Creek (milepost 1.5), Cameron Creek (milepost 10.1), and Little Blue Joint Creek (milepost 1.4) and Their Unburned Index Sites

The data in Figure 18 suggests that recovery of temperatures is occurring, especially in Laird and Little Blue Joint creeks (i.e. the data points have moved very close to or even under the "0 degree day" line over time). In 2013, both the Laird Creek and Little Blue Joint Creek sites were cooler than their unburned index sites for the first time since the 2000 fires.

Key Findings of the Forest's Water Temperature Monitoring

- Stream temperatures are increasing across the Forest in response to the warming climate. Increases have been observed in all types of streams (big and small) on all parts of the Forest (wilderness and managed). Degree days have increased by 75 to 150 units in most streams since 1993, which roughly correlates to around a 1-2º C increase in the mean daily water temperature.
- The decline of bull trout populations observed in some streams since 2006 is likely related to stream temperature increases. The most vulnerable reaches occur at the lower elevations where the lower limit of bull trout distribution currently exists and non-native trout competitors are more numerous. If water temperatures continue to rise in future years, bull trout distribution will shrink across the Forest, with the populations at the lowest elevations disappearing first. For example, the findings of Eby et al. (2014) indicate that since the mid 1990's, bull trout have abandoned some of their lower elevation habitats in the East Fork Bitterroot River watershed. *Eby, L.A., O. Helmy, L.M. Holsinger, and M.K. Young. 2014. Evidence of Climate-Induced Range Contractions in Bull Trout, Salvelinus confluentus in a Rocky Mountain Watershed, U.S.A. PLoS ONE 9(6): e98812. Doi:10.1371/journal.pone.0098812*
- The most conservative climate models suggest warming in the range of 1.6º C over the next 50 years, which could result in suitable bull trout habitat being reduced by 30-40% on the Forest. Some of the more liberal models suggest warming in the range of 6º C over the next 50 years, which could eliminate suitable bull trout habitat from all but the highest elevations.
- Stream warming may be a key factor driving the expansion of brown trout populations in the East Fork Bitterroot River, West Fork Bitterroot River, Sleeping Child Creek, and lower Camp Creek. A cursory comparison of our fish distribution and water temperature data indicates that brown trout are more likely to occur at higher numbers in stream reaches that accumulate more than 800 degree days per summer.
- Most of the Bitterroot Headwaters TMDL water temperature monitoring sites in the East Fork Bitterroot River, West Fork Bitterroot River, Hughes Creek, Overwhich Creek, and Nez Perce Fork have consistently failed to meet their water temperature goals. The upper Hughes Creek (river mile 9.0) and West Fork Bitterroot River

(river mile 40.0) sites have had the best success of meeting their goals. However, the West Fork 40.0 site has not met its goal since fires burned a large portion of the West Fork headwaters in 2011 and 2012. Given current and projected climate trends, most of the temperature goals in the Headwaters TMDL are probably unattainable.

- Temperature restoration projects for the East Fork Bitterroot River should focus on the state and private portions of Cameron, Camp, Medicine Tree, Tolan, Laird, and Warm Springs Creeks, and the Sula Basin section of the East Fork between Tolan Creek and the Sula canyon. Above Mink Creek, temperature restoration opportunities are more limited and tributary inputs are closer to natural conditions.
- Monitoring indicates that timber sales that retain intact RHCA buffers are not having a detectable effect on stream temperatures.
- Three streams that were severely burned in 2000 (Laird Creek, Little Blue Joint Creek, and the middle portion of Cameron Creek) appear to be recovering their pre-fire temperatures, particularly in Laird and Little Blue Joint creeks.
- Reservoirs and dam operations on the Forest affect water temperatures. The influence is site specific because the dams vary in depth and operational procedures. The effect on temperature may be measurable a few miles downstream.

BULL TROUT REDD SURVEYS:

Starting in 1994, Forest and MFWP fisheries biologists have cooperatively conducted annual bull trout redd surveys in three streams: (1) Meadow Creek on the Sula District; (2) Deer Creek on the West Fork District; and (3) Daly Creek on the Darby District. With the exception of a few missed years, redd counts have been conducted in these reaches every year since 1994. In 2000, in response to a bull trout radio telemetry project, a fourth bull trout redd survey reach was added in the upper East Fork Bitterroot River in the Anaconda-Pintlar Wilderness Area. In 2005, a fifth bull trout redd survey reach was temporarily added (until 2010) in Chicken Creek on the West Fork Ranger District in response to a U.S. Fish and Wildlife formal consultation and biological opinion (2006, Litchford and Hawkes Ditch Bill Easements). The Chicken Creek reach was surveyed for the last time in 2010, which completed the monitoring requirement in the Litchford and Hawkes biological opinion.

Meadow Creek Redd Survey (Sula Ranger District): The "Meadow reach" is a two-mile long section of Meadow Creek that the Forest has monitored each autumn for bull trout redds since 1994. In 2014, we conducted the redd survey on September 19th. We counted seven redds in 2014, which was on the lower end of the range counted between 1994 and 2015 (range = 1-21 redds). In 2015, we conducted the redd survey on September 22nd. We counted 13 redds in 2015, which was near the middle of the range counted between 1994 and 2015 (range = 1-21 redds). In 2014 and 2015, nearly all of the redds were concentrated in the C-channel habitat below the lower exclosure fence or within the lower exclosure fence. Over the years, this patch of habitat has been the best producer of redds. The habitat below the lower exclosure is not fenced and it is sensitive to grazing pressure, so it will need to be closely watched for bank trampling effects in the years that the Meadow Creek drainage is grazed (i.e. it was rested in 2011-15). There has not been a good correlation between the number of redds counted and the number of juvenile bull trout captured in electrofishing mark/recapture estimates in Meadow Creek. Redd counts have fluctuated at low numbers, while juvenile bull trout estimates have remained relatively stable. Either we cannot reliably count bull trout redds in Meadow Creek (i.e. most of the bull trout may be resident fish whose small redds are difficult to see), or the bull trout are spawning in areas where we are not looking for them. We plan on conducting the Meadow Creek redd survey again in September, 2016.

Upper East Fork Bitterroot River Redd Survey (Sula Ranger District): This reach was established by MFWP biologists in 2000 in response to several radio-tagged bull trout moving in this reach to spawn from the lower East Fork. Due to the lack of redds found in previous years, MFWP biologists have not surveyed this reach since 2007. It is unknown at this time if the reach will be surveyed in 2016.

Deer Creek Redd Survey (West Fork Ranger District): The Forest has conducted a bull trout redd survey in the lower 1.3 miles of Deer Creek since 1994. In 2014, we conducted the redd survey on September 22nd. We counted four redds in 2014, which was on the lower end of the range counted between 1994 and 2015 (range = 0-16 redds). In 2015, we conducted the redd survey on October 1st. We counted five redds in 2015, which was on the lower end of the range counted between 1994 and 2015 (range = 0-16 redds). In 2014 and 2015, the redds were widely scattered throughout the lower half of the reach; none were not concentrated in any particular area. Bull trout and brook trout occur at similar densities in lower Deer Creek. As a result, we are unable to accurately distinguish between the redds of the two species. We have reported the total number redds counted, but some of those could have been made by brook trout. We plan on conducting the Deer Creek redd survey again in September or October, 2016.

Chicken Creek Redd Survey (West Fork Ranger District): This reach was established by Forest fisheries biologists in 2005 in response to a consultation with the U.S. Fish and Wildlife Service. The reach was surveyed in 2005-2010. The number of redds counted was 13 (2005), 15 (2006), 16 (2007), 21 (2008), 15 (2009), and 16 (2010). The 2010 survey completed the monitoring requirement in the Litchford and Hawkes Ditch Bill Easements biological opinion. Survey of the Chicken Creek reach was discontinued in 2011. At this time, there are no plans to survey redds in Chicken Creek in 2016.

Daly Creek Redd Survey (Darby Ranger District): The Forest has conducted a bull trout redd survey in a 1-mile long reach of Daly Creek since 1994. In the last five years 37 to 49 redds have been counted. This has been surprisingly consistent, and is in the middle of the range (20 to 77 redds) observed since 1994. Redds were the size of those typically made by resident bull trout (1 to 2 ft^2). In recent history, the drainage above the surveyed section has been intermittently affected by small to moderate amounts of fire, consistently affected by a few obvious points where sediment is transported from Hwy 38 to Daly Creek's ephemeral channels, and a few other disturbances like dispersed camping and illegal near-stream firewood collection. We plan on continuing to survey redds in Daly Creek in early October, 2016.

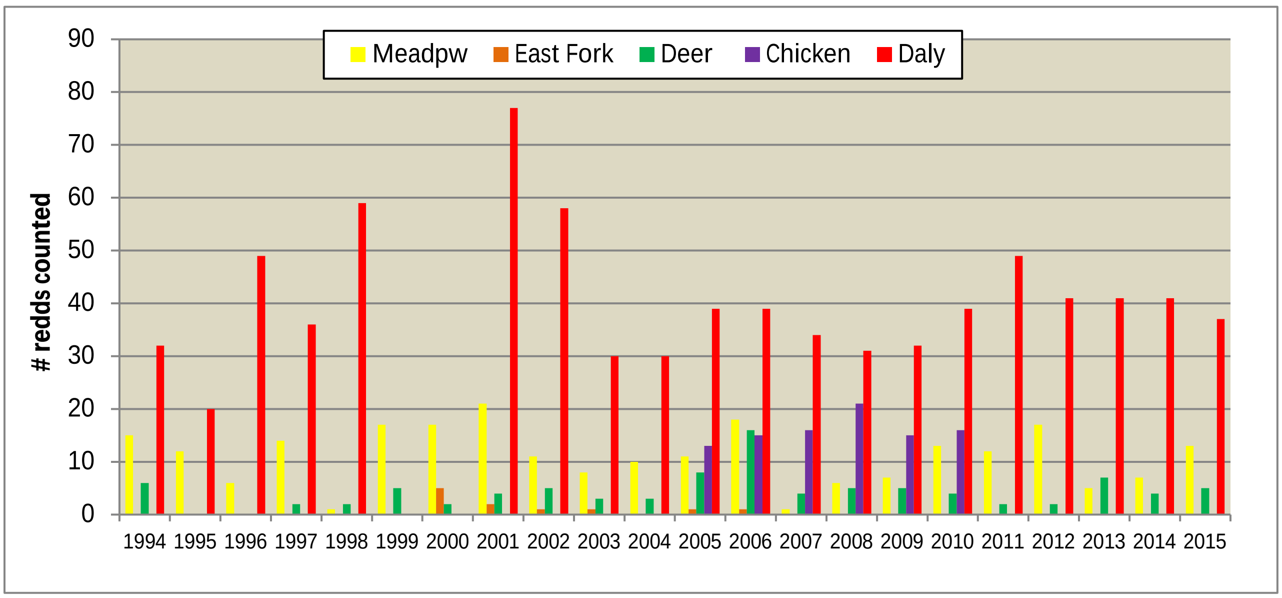

Figure 19 - Annual Bull Trout Redd Counts, 1994 to 2015

Table 7 - Annual Bull Trout Redd Counts, 1994 to 2015

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Meadow Creek (D3)	15	12	6	14	1	17	17	21	11	8	10	11	18	1	6	7	13	12	17	5	7	13
East Fork (D3)	ND	ND	ND	ND	ND	ND	5	2	1	1	0	1	1	0	ND	ND	ND	ND	ND	ND	ND	ND
Deer Creek (D4)	6	0	0	2	2	5	2	4	5	3	3	8	16	4	5	5	4	2	2	7	4	5
Chicken Creek (D4)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	15	16	21	15	16	ND	ND	ND	ND	ND

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Daly Creek (D2)	32	20	49	36	59	ND	ND	77	58	30	30	39	39	34	31	32	49	49	41	41	41	37

ND = No data, not surveyed

Key Findings of the Forest's Monitoring of Bull Trout Redds

- With the possible exception of Daly Creek, redd counts have not been a reliable index of bull trout population trends on the Bitterroot National Forest. Either we are: (1) looking in the wrong places (e.g. what we think is good spawning habitat is not what most of the bull trout are using for spawning); (2) looking in the right places but cannot reliably identify the redds that are present (e.g. most of the redds are small resident redds that are difficult to see); or (3) there are just very few migratory redds, and the redds that are present are widely scattered. Forest and MFWP biologists are reasonably certain that the poor correlation that occurs between redd counts and the electrofishing data is caused by a combination of (2) and (3). Moving the date of survey up from October to the third week in September definitely helped us find more redds in Meadow Creek, but didn't seem to make much of a difference in Deer Creek or Daly Creek. At least in the East Fork Bitterroot River drainage, it appears to be better to conduct redd surveys in the third week of September rather than October.
- Redd counts are best used as an index of population trend <u>after</u> key spawning areas have been identified. Without knowing where the key spawning areas are, redd counts have very limited utility. In 2008, Leslie Nyce, a University of Montana graduate student, used radio-telemetry to identify that the East Fork Bitterroot River and its larger tributaries (Orphan and Clifford creeks) in the Anaconda-Pintlar Wilderness Area appear to be key spawning area for migratory bull trout. Unfortunately, the number of migratory bull trout in the East Fork appears to have declined to such low numbers that it is questionable whether doing more redd surveys would provide any additional information in monitoring population trends. Since 2000, MFWP biologists already had an established redd survey reach (the Upper East Fork redd survey, discussed above) located in the vicinity where the radio-tagged bull trout went. However, the number of redds counted between 2000 and 2007 was so low that MFWP biologists have not surveyed the reach since 2007.
- Daly Creek appears to be the one possibly reliable index of resident bull trout population trends on the Bitterroot National Forest. The resident bull trout spawn in this area at fairly high density, and the area is conducive for red surveys.
- Radio telemetry could be used to determine where the bull trout in Painted Rocks Lake go to spawn. Trapping data collected by researchers working in Slate Creek in 2003 indicate that migratory bull trout in Painted Rocks Reservoir may be more common than was originally believed, but little is known about where those bull trout spawn. In August 2010, a 19-inch migratory adult bull trout spawner was captured in Little Boulder Creek (tributary to Painted Rocks Reservoir), upstream of the Road 1130 culvert. Adult bull trout spawners have also been periodically seen or captured during electroshocking surveys in low numbers in Blue Joint Creek, Deer Creek, Chicken Creek, Hughes Creek, Overwhich Creek, and the upper West Fork. A few adult bull trout spawners have also been seen in Blodgett Creek on the Stevensville Ranger District.

Mussel Surveys

The western pearlshell mussel (Margaritifera falcata) was added to the Bitterroot National Forest's sensitive species list in 2010. It is the only native mussel that occurs west of the Continental Divide in Montana. The preferred habitat is cool to cold water running streams with stable pebble and gravel substrates and low to moderate gradients (1-2%). These types of streams are generally equivalent to the Rosgen C4 channel type. Western pearlshell mussels are sometimes found in larger rivers with higher gradients embedded in sand or gravel substrates tucked among boulders and cobbles. The average wetted stream width that viable western pearlshell mussel populations have been found in is 5.2 m plus/minus 1 m (14-20 feet) (Stagliano, 2010). Western pearlshell mussels are usually absent in streams smaller than 2 m (6.6 feet) wide. Western pearlshell mussels require a salmonid host to complete their life cycle. In western Montana, that host is usually the westslope cutthroat trout. The average life span of western pearlshell mussels is approximately 60-70 years, and some individuals are thought to live 100 years. Western pearlshell mussels may be an excellent biological indicator of water quality because the species is sedentary, may be sensitive to environmental changes, and is long-lived. Recent surveys indicate that mussels are continuing to decline in many watersheds across western Montana (Stagliano, 2015).

Stagliano, D. 2010. Freshwater Mussels in Montana: Comprehensive Results from 3 years of SWG Funded Surveys. Report prepared for Montana Department of Fish, Wildlife, and Parks. Montana Natural Heritage Program. Helena, Montana.

Stagliano, D. 2015. Re-evaluation and Trend Analysis of Western Pearlshell Mussel (SWG Tier 1) Populations across Watersheds of Western Montana. Report of State Wildlife Grant (SWG) FY2015 Activities to Montana Fish, Wildlife, and Parks. FWP Agreement #150027. Montana Natural Heritage Program. Helena, Montana. April, 2015.

Since 2007, limited and sporadic mussel surveys have been conducted in Forest streams. So far, western pearlshell mussels have only been found in six streams on or near the Bitterroot National Forest. The six streams are:

1. Cameron Creek (mouth to upper end of Shining Mountain Ranch)
2. Little Sleeping Child Creek (lower reaches downstream of private ponds)
3. East Fork Bitterroot River (near mouths of Laird and Cameron creeks)
4. West Fork Bitterroot River (near Applebury Landing boat launch)
5. Bitterroot River (near Darby)
6. Selway River (near Running Creek)

Viability of the western pearlshell mussel populations in Cameron Creek and Little Sleeping Child Creek are rated as "good/fair", while the populations in the East and West Forks of the Bitterroot River are rated as having "poor" viability (Stagliano, 2015). The viability of the Bitterroot River population is rated as "fair/poor" (Stagliano, 2015). The Selway River population is not included in Stagliano's reports (2010, 2015), but is likely the healthiest population on the Forest.

Mussel surveys were conducted in six streams in 2015. No mussels or shells were found in any of the surveys. Table 8 summarizes the mussel surveys that were conducted on the Forest in 2015.

Table 8 - Mussel Surveys Conducted in 2015

Stream	River Mile	GPS Location	Date of Survey	Length of Survey	Rosgen Channel Type	Mussels Found?	Survey Notes
Camp	0.1	N45.83641^0 W113.97860^0	9-14-2015	400 feet	B4	No	Snorkel survey; beaver-impounded reach; cobble-gravel substrate coated by varying depths of sand; may have some suitable habitat when not impounded
Cayuse	0.1	N45.70524^0 W114.61576^0	8-24-2015	300 feet	B4	No	Survey with plexiglass-bottomed bucket; large gravel substrate with sand deposition in low gradient areas; may be suitable habitat
Deep	6.8	N45.70482^0 W114.61635^0	8-24-2015	200 feet	B3	No	Survey with plexiglass-bottomed bucket; cobble-gravel substrate; low fines; may be suitable habitat
Hughes	0.6	N45.61580^0 W114.29852^0	9-10-2015	200 feet	B4	No	Snorkel survey; cobble-gravel substrate; low fines; may be suitable habitat
Hughes	1.6	N45.60681^0 W114.28089^0	9-10-2015	200 feet	C3	No	Snorkel survey; cobble-gravel substrate; low fines; may be suitable habitat
Hughes	4.2	N45.60777^0 W114.24342^0	9-14-2015	200 feet	C4	No	Snorkel survey; gravel substrate; low fines; may be suitable habitat
Hughes	8.7	N45.59018^0 W114.17379^0	8-26-2015	600 feet	B3	No	Snorkel survey; cobble substrate; low fines; may be too coarse for suitable

Stream	River Mile	GPS Location	Date of Survey	Length of Survey	Rosgen Channel Type	Mussels Found?	Survey Notes
							habitat?
Lick (West Fork District)	0.3	N45.93962^0 W113.71059^0	8-27-2015	200 feet	C4	No	Snorkel survey; gravel substrate; low fines; may be suitable habitat
West Fork Bitterroot River @ Coal Creek Road bridge	27.6	N45.66920^0 W114.30508^0	9-16-2015	200 feet	B4	No	Snorkel survey; cobble-gravel substrate; thin layer of silt from recent mudslides; may be suitable habitat
West Fork Bitterroot River @ Alta campground	31.5	N45.62542^0 W114.30247^0	9-16-2015	200 feet	B3/B4	No	Snorkel survey; cobble-gravel substrate; may be suitable habitat
West Fork Bitterroot River @ Thunder Creek	35.5	N45.58142^0 W114.31989^0	9-16-2015	200 feet	C4	No	Snorkel survey; gravel substrate; a lot of sand and silt from recent mudslides; may be suitable habitat when fire-caused fires are scoured out of area
West Fork Bitterroot River @ Salt Creek	38.0	N45.54889^0 W114.31648^0	9-16-2015	200 feet	C4	No	Snorkel survey; gravel substrate; thin layer of sand and silt from recent mudslides; may be suitable habitat
West Fork Bitterroot River @ Johnson Creek	39.5	N45.53810^0 W114.31960^0	8-26-2015	200 feet	B4	No	Survey with plexiglass-bottomed bucket; gravel-cobble substrate; low fines; may be suitable habitat

RESEARCH:

Bull Trout Fire/Climate Distribution Study

During the 2009-11 field seasons, Olga Helmy, a PhD fisheries student at the University of Montana, used presence-absence electroshocking to inventory and map the distribution of bull trout in 77 sites in tributaries to the East Fork Bitterroot River. These sites had been previously sampled in 1993-95 by Rich et al. (2003). The goal of Helmy's field work is to document how climate change and fire have altered the distribution of bull trout on the Bitterroot National Forest since the mid 1990's. In 2012, Lisa Eby, fisheries professor at the University of Montana, continued the bull trout distribution project that was started by Helmy. Eby et al. (2014) found that while bull trout are still widely distributed across the East Fork Bitterroot River basin (i.e. they were found in every tributary they were historically present – but not at every site within that tributary), their distribution is shrinking because of climate-driven losses of suitable habitat at the lower elevations. Eby et al. (2014) detected bull trout at only 26 of the 41 sites where Rich et al. (2003) found them. Of the 36 sites in which Rich et al. (2003) failed to detect bull trout, Eby et al. (2014) found them at 5 sites. The citations for Rich et al. (2003) and Eby et al. (2014) are listed below, along with the Eby et al. (2014) abstract:

Rich, C.F., T.E. McMahon, B.E. Rieman, and W.L. Thompson. 2003. Local-habitat, watershed, and biotic features associated with bull trout occurrence in Montana streams. Transactions of the American Fisheries Society 132:1053-1064.

Eby, L.A., O. Helmy, L.M. Holsinger, and M.K. Young. 2014. Evidence of Climate-Induced Range Contractions in Bull Trout, Salvelinus confluentus in a Rocky Mountain Watershed, U.S.A. PLoS ONE 9(6): e98812. Doi:10.1371/journal.pone.0098812

Abstract

Many freshwater fish species are considered vulnerable to stream temperature warming associated with climate change because they are ectothermic, yet there are surprisingly few studies documenting changes in distributions. Streams and rivers in the U.S. Rocky Mountains have been warming for several decades. At the same time these systems have been experiencing an increase in the severity and frequency of wildfires, which often results in habitat changes including increased water temperatures. We resampled 74 sites across a Rocky Mountain watershed 17 to 20 years after initial samples to determine whether there were trends in bull trout occurrence associated with temperature, wildfire, or other habitat variables. We found that site abandonment probabilities (0.36) were significantly higher than colonization probabilities (0.13), which indicated a reduction in the number of occupied sites. Site abandonment probabilities were greater at low elevations with warm temperatures. Other covariates, such as the presence of wildfire, nonnative brook trout, proximity to areas with many adults, and various stream habitat descriptors, were not associated with changes in probability of occupancy. Higher abandonment probabilities at low elevation for bull trout provide initial evidence validating the predictions made by bioclimatic models that bull trout populations will retreat to higher, cooler thermal refuges as water temperatures increase. The geographic breadth of these declines across the region is unknown but the approach of revisiting historical sites using an occupancy framework provides a useful template for additional assessments.

Sculpin Distribution/Climate and Fire Food Web Studies

During the 2010-14 field seasons, Mike LeMoine, a PhD fisheries student at the University of Montana, used presence-absence electroshocking and drift nets to inventory the distribution of sculpin on the Bitterroot National Forest, and study how wildfire affects stream food webs and the diet of westslope cutthroat trout. The goals of Mike's field work are to: (1) document how sculpin are responding to warming stream temperatures; (2) show how sculpin distribution has changed on the Bitterroot National Forest over the past 20 years; and (3) document how wildfire affects stream food webs and the diet of westslope cutthroat trout. Mike's abstracts are included below:

Abstract

The dispersal of stream fishes is limited within dendritic networks. Consequently, many stream fishes are predicted to be substantially influenced by climate change and physical barriers that prevent movement into thermally suitable habitats. In western North America, bull trout are considered a good umbrella species for conservation; however, they are more mobile and less impacted by obstacles than many native stream fishes. With Montana Fish Wildlife and Parks and the U.S. Forest Service, we geo-referenced presence–absence records from 1991-1994 and expanded the existing dataset in 2010-2014 to increase sites revisited two decades later. We assessed the change in occupancy of native stream fishes with differing dispersal abilities in the Bitterroot River basin, MT. We used a Bayesian multi-season occupancy framework to examine changes in different species distribution over twenty years and investigate different landscape drivers that maybe associated with any changes in distribution detected. Our results reveal small, weak swimming, cold water fishes (i.e., sculpin) are negatively responding to warming habitats, more so than bull trout and other native trout species, which is attributed to the compounding effects of warming and barriers to movement. Our results combined with other observations suggest weak swimming fishes may be quietly disappearing from Montana streams. These trends highlight the limitations of a reliance on umbrella species for aquatic conservation.

Abstract

Wildfire frequency and severity in the western U.S. has increased in recent decades and is predicted to increase with climate change. Wildfire can alter stream characteristics resulting in warmer water temperatures, higher sediment and nutrient loading, as well as shifts in aquatic benthic community composition. Even though short-term impacts have been demonstrated, few studies have looked into decadal impacts on stream food webs. We investigated the decadal influences of wildfire on the composition of invertebrate drift and westslope cutthroat trout diet composition by comparing drift and diets in burned and unburned streams to evaluate whether wildfire was impacting the percent of terrestrial contribution to stream food webs and/or food web flows. We deployed drift nets and collected fish diets in July, August, and September. All samples were returned to the lab for identification to the highest resolution necessary to determine habitat of origin (order or family). Fish diets reflected our drift samples. There were no significant differences between burn treatment and the portion of terrestrial insects in the drift or diets of trout. But, invertebrate community composition did differ between burned and unburned streams indicating long-term decadal impacts of wildfire on stream food webs.

CULVERT INVENTORIES AND REPLACEMENTS:

The Forest Plan as amended by INFISH and PACFISH directs the Forest to "provide and maintain fish passage at all road crossings on existing and potential fish-bearing streams" (INFISH/PACFISH standard RF-5). In order to meet this standard, Forest fisheries biologists and engineers have focused much of their attention in recent years on the identification and elimination of fish passage barriers at culverts.

Culvert Inventories: During the 2003 field season, the majority (> 80%) of the fish-bearing culverts on the Bitterroot National Forest were surveyed with the Fish Crossing protocol to assess whether or not they function as a passage barrier to trout. The FishXing model predictions were checked and validated by Forest fisheries biologists. Most of the fish-bearing culverts that did not receive a Fish Crossing survey in 2003 have been field checked by Forest biologists on at least one occasion.

During the 2007 field season, 43 fish-bearing culverts on five Forest highways were surveyed with the Fish Crossing protocol. The highways surveyed included: (1) U.S. Highway 93 between Darby and Lost Trail Pass; (2) the East Fork Highway; (3) the West Fork Highway; (4) the Skalkaho Highway; and (5) the paved portion of the Nez Perce Road. The results indicate that 58% of the highway culverts are an upstream barrier to juvenile trout during some time of the year, 21% are potential barriers, and 21% provide year-round passage. The results for adult trout were similar, with 51% of the culverts identified as barriers, 28% as potential barriers, and 21% providing year-round passage.

Table 9 summarizes our most current knowledge of fish culvert passage status on the Forest. The numbers in the table may differ from past years reports because they get adjusted as new information becomes available, or as barriers are eliminated through replacement or removal.

Table 9 – Fish Passage Barriers at Culverts

Location	# of Fish-Bearing Culverts	# Known or Suspected to be Passage Barriers	# Unknown – Not Seen or Surveyed	# Likely to be Offering Suitable Fish Passage Conditions
Sula and W. Fork R.D.	104	59 (57%)	0 (0%)	45 (43%)
Stevensville and Darby R.D.	55	43 (78%)	0 (0%)	12 (22%)
Montana DNRC land	6	1 (17%)	0 (0%)	5 (83%)

The elimination of fish passage barriers at culverts is a key objective for the Forest fisheries and engineering programs. Since 2000, 94 culverts have been replaced or removed to improve fish passage on Bitterroot National Forest and adjacent state lands and highway corridors (Table 10). The Bitterroot National Forest has conducted the bulk of the culvert replacements and removals (85 of 94). The rest have occurred on Sula State Forest lands (5 culverts), U.S. Highway 93 (3 culverts during the Sula North/South reconstruction phase), or the West Fork Highway (1 culvert, Slate Creek).

In fiscal years 2014 and 2015, the Forest removed three fish barrier culverts and replaced three fish barrier culverts:

1. Arasta Creek, Road 640 (removal) (Stevensville District, 2014)
2. Sawmill Creek, Road 62127 (removal) (Stevensville District, 2014)
3. West Creek tributary 2.0, Road 13410 (removal) (West Fork District, 2013)
4. Sheep Creek, Road 5677 (replacement) (West Fork District, 2015)
5. Little Blue Joint Creek, Road 5658 (replacement) (West Fork District, 2015)
6. Soldier Creek, Road 091 (replacement) (West Fork District, 2015)

Implementation Monitoring of Culvert Replacements: The Bitterroot Headwaters TMDL recommends that the Forest monitor any new culvert replacements to ensure that fish passage is being adequately maintained. **Error! Reference source not found.**14 lists the fish passage culvert replacements and removals that have occurred since 2000, and summarizes their current fish passage status based on our most recent monitoring visits. The current fish passage status of each culvert was classified as “fully functioning”, “partially functioning”, or “not functioning”. These categories are defined as:

- *Fully functioning* = native substrates are present throughout the culvert barrel and appear to be stable; there may be some thinning of substrate material since installation but substrate still covers the entire bottom of the culvert barrel; there are no prohibitive vertical drops on the inlet or outlet; all sizes and species of fish can pass through the culvert at high and low flows

- *Partially functioning* = since replacement, some of the substrate material has been flushed from the culvert barrel and now at least half of the barrel has been scoured bare or contains minimal substrate material; there are no prohibitive vertical drops on the inlet or outlet; culverts that provide good fish passage at high flows but lose their surface water at low flows fall into this category, as do culverts that are undersized but still maintain a roughened bottom of larger substrates throughout their culvert barrel; adult fish can still pass through the culvert at the majority of flows, but passage of juvenile fish is probably restricted at higher flows due to prohibitive water velocities inside of the barrel or at lower flows due to loss of surface water
- *Not functioning* = since replacement, all or most of the substrate material has been scoured from the culvert barrel or prohibitive vertical drops may have developed on the inlet or outlet (in some cases they haven't, but the barrel is still bare of substrate); the majority of adult and juvenile fish probably cannot pass through the culvert at high or low flows

Table 10 – Status of Culverts Replaced or Removed to Eliminate Fish Passage Barriers, 2000 to Present

District[1]	Stream	Road	Year Replaced or Removed?	Fully Functioning	Partially Functioning	Not Functioning
D4	Sheep Creek	6223	Replaced, 2001			X
D4	Washout Creek	6223	Replaced, 2001	X		
D4	Two Creek	732	Replaced, 2001		X	
D4	Trout Creek	Tr #674	Removed, 2001	X		
D4	Nelson Creek	468	Replaced, 2002	X		
D4	Gemmell Creek	468	Replaced, 2002	X		
D4	Sentimental Creek	13482	Replaced, 2003	X		
D4	Sand Creek	362	Replaced, 2003 (BAR)	X		
D4	Magpie Creek	362	Replaced, 2003 (BAR)	X		
D4	Took Creek	362	Replaced, 2003 (BAR)	X		
D4	Took Creek	1303	Replaced, 2003 (BAR)	X		
D4	Gabe Creek	468	New bridge, 2004	X		
D4	Scimitar Creek	Non-syst	Removed, 2007	X		
D4	Coal Creek	5662	Replaced, 2007 (BAR)	X		
D4	Castle Creek (lower)	49	Replaced, 2008 (BAR)	X		
D4	East Piquett Creek	731	Replaced, 2009 (BAR)	X		
D4	Mine Creek	5688	Replaced, 2010 (BAR)	X		
D4	Elk Creek (lower)	13833	Removed, 2010 (BAR)	X		
D4	Elk Creek (upper)	13833	Removed, 2010 (BAR)	X		
D4	Pierce Creek	5629	Replaced, 2011		X	
D4	Castle Creek (middle)	49	Replaced, 2011	X		
D4	Pete Creek	468	New bridge, 2011	X		
D4	Baker Creek (north)	5629	Replaced, 2011	X		
D4	Baker Creek (south)	5629	Replaced, 2011	X		
D4	Woods Creek	5672	Removed, 2012	X		
D4	Woods Creek trib 5.4	5672	Removed, 2012	X		
D4	Little Boulder Creek	1130	Replaced, 2013	X		
D4	Halfway Creek	468	Replaced, 2013	X		
D4	Schumaker Creek	468	Replaced, 2013		X	
D4	Scimitar Creek	468	Replaced, 2013			X
D4	East Piquett Creek trib 2.0	13411	Removed, 2013	X		
D4	Pierce Creek	13466	Removed, 2013	X		
D4	West Creek trib 2.0	13410	Removed, 2013	X		
D4	Sheep Creek	5677	Replaced, 2015	X		
D4	Little Blue Joint Creek #	5658	Replaced, 2015	X		
D4	Soldier Creek	091	Replaced, 2015	X		
D3	Gilbert Creek	370	Replaced, 2000	X		
D3	Laird Creek	370	Replaced, 2000		X	

D2 – Darby District, D3 – Sula District, D4 – West Fork District, DNRC – Montana Department of Natural Resources, MDOT – Montana Department of Transportation, FHA – Federal Highway Administration, BAR – Burned Area Recovery Project

District[1]	Stream	Road	Year Replaced or Removed?	Fully Functioning	Partially Functioning	Not Functioning
D3	Laird Creek	5615	Replaced, 2000	X		
D3	Reimel Creek	727	Replaced, 2000	X		
D3	Needle Creek	724	Replaced, 2001		X	
D3	WF Camp, trib 0.1 (lower)	729-B	Replaced, 2001			X
D3	WF Camp, trib 0.1 (upper)	729-B	Replaced, 2001			X
D3	Cameron Creek	311	Replaced, 2001	X		
D3	Bugle Creek	725	Replaced, 2003 (BAR)	X		
D3	Crazy Creek	370-A	Replaced, 2003 (BAR)	X		
D3	West Fork Camp Creek	729	Replaced, 2003 (BAR)	X		
D3	West Fork Camp, trib 0.9	8112	Replaced, 2003 (BAR)	X		
D3	West Fork Camp, trib 1.0	8112	Replaced, 2003 (BAR)	X		
D3	Diggins Creek	727	Replaced, 2003	X		
D3	Springer Creek	Non-syst	Removed, 2006	X		
D3	West Fork Camp, trib 0.1	13340	Removed, 2006	X		
D3	Lyman Creek, trib 1.8	13304	Removed, 2006	X		
D3	Lyman Creek, trib 1.8	13304	Removed, 2006	X		
D3	Moose Creek	726	New bridge, 2007 (BAR)	X		
D3	Hart Creek	311	Replaced, 2008	X		
D3	Hart Creek	73180	Replaced, 2008	X		
D3	Mink Creek	5753	Replaced, 2008	X		
D3	Meadow Creek	5758	New bridge, 2008	X		
D3	Meadow Creek	725	New bridge, 2009	X		
D3	Warm Springs Creek	370	New bridge, 2011	X		
D3	West Fork Camp, trib 0.1	729	Replaced, 2011	X		
D3	Lodgepole Creek	73279	Removed, 2013	X		
D2	North Rye Creek, trib 2.1	321	Replaced, 2000			X
D2	Rye Creek, trib 9.1 (lower)	311	Replaced, 2001		X	
D2	Rye Creek, trib 9.1 (upper)	5613	Replaced, 2001	X		
D2	Gird Creek	1365	Replaced, 2001		X	
D2	Railroad Creek	75	Replaced, 2005 (BAR)	X		
D2	Hog Trough Creek	75	Replaced, 2005 (BAR)	X		
D2	Weasel Creek	75	Replaced, 2005 (BAR)	X		
D2	Rye Creek, trib 12.3	75	Replaced, 2005 (BAR)	X		
D2	Rye Creek, trib 12.3	5607	Replaced, 2005 (BAR)	X		
D2	Cathouse Creek	Non-syst	Removed, 2006	X		
D2	Cathouse Creek, trib 0.9	Non-syst	Removed, 2006	X		
D2	North Rye Creek	321	Replaced, 2006 (BAR)	X		
D2	Cathouse Creek	1126	Replaced, 2007	X		
D2	Two Bear Creek	85D	New bridge, 2010	X		
D2	South Fork Chaffin Creek	374	Replaced, 2012	X		
D2	South Fork Chaffin Creek	374-A	Replaced, 2012	X		
D2	Skalkaho Creek	75	New bridge, 2013	X		
D1	North Fork Willow Creek	13131	Removed, 2009	X		
D1	Sawmill Creek	62384	Removed, 2010	X		
D1	Sawmill Creek	62127	Removed, 2014	X		
D1	Arasta Creek	640	Removed, 2014	X		
DNRC	North Cameron Creek	1397	Replaced, 2000	X		
DNRC	North Cameron Creek	73160	Replaced, 2000	X		
DNRC	Lyman Creek	DNRC	Replaced, 2000	X		
DNRC	Praine Creek	DNRC	Replaced, 2001	X		
DNRC	Andrews Creek	DNRC	Replaced, 2007	X		
MDOT	Warm Springs Creek	Hwy 93	Replaced, 2002		X	
MDOT	Andrews Creek	Hwy 93	Replaced, 2002		X	
MDOT	Praine Creek	Hwy 93	Replaced, 2002		X	

District[1]	Stream	Road	Year Replaced or Removed?	Fully Functioning	Partially Functioning	Not Functioning
FHA	Slate Creek	WF Hwy	Replaced, 2003	X		

D1-Stevensville District, D2 – Darby District, D3 – Sula District, D4 – West Fork District, DNRC – Montana Department of Natural Resources, MDOT – Montana Department of Transportation, FHA – Federal Highway Administration
= the culvert on the Road 5658 crossing of Little Blue Joint Creek has been replaced twice (2000 and 2015)

Bridges: Eight of the fish barrier culverts have been replaced with new bridges. All of the bridges have been successful at maintaining year-round aquatic organism passage with no adverse channel changes occurring (e.g. headcutting) to threaten passage. There has been no need to install grade control structures at the bridge sites. The fish barrier culverts that have been replaced with bridges are:

1. Gabe Creek, Road 468 (2004)
2. Moose Creek, Road 726 (2007)
3. Meadow Creek, Road 5758 (2008)
4. Meadow Creek, Road 725 (2009)
5. Two Bear Creek, County Road 85-D (2010)
6. Warm Springs Creek, Road 370 (2011)
7. Pete Creek, Road 468 (2011)
8. Skalkaho Creek, Road 75 (2013)

NEPA Backlog: There are currently 78 fish barrier culvert replacements or removals on the Forest that have NEPA analysis completed, but are awaiting implementation (Table 11). Of those, one (Johnson Creek, Road 091) is under contract to be replaced with a new bridge in 2016 (highlighted in gray in Table 11).

Twenty-one of the culverts listed in Table 11 have survey and design completed, but lack funding to contract and implement. The Forest is pursuing opportunities to survey, design, and contract these backlog culverts as opportunities arise, but it is a slow process because the work is expensive and implementation funds are very limited. Culverts that have NEPA completed but the Forest has dropped from consideration for various reasons are not listed in Table 11. The Forest now has NEPA analysis completed for nearly all of its known fish barrier culverts. Table 11 lists the fish barrier culvert replacements or removals that have NEPA analysis completed, but have not been implemented.

Table 11 – Backlog of Fish Barrier Culverts with Completed NEPA Analysis

Stream	Road #	NEPA Document and Date of Decision
Rye Creek	Road 5612	Burned Area Recovery FEIS/ROD, 2001
North Rye Creek	Road 8111	Burned Area Recovery FEIS/ROD, 2001
Pierce Creek	Road 363	Frazier Interface EA/DN, 2003
Threemile Creek	Road 640	Threemile Bridge and Culvert EA, 2005
Bertie Lord Creek	Road 5786	Middle East Fork FEIS/ROD, 2006
Bertie Lord Creek, trib 3.5	Road 5786	Middle East Fork FEIS/ROD, 2006
Springer Creek	Road 13302	Middle East Fork FEIS/ROD, 2006
Spoon Creek	Road 13225	Trapper Bunkhouse FEIS/ROD, 2008
North Fork Willow Creek	Road 969-A	NF Willow Creek Culvert Replacements For Fish Passage DM, 2008
Beavertail Creek	Road 361-A	West Fork District Fish Culverts EA/DN, 2010
Beavertail Creek	Road 361	West Fork District Fish Culverts EA/DN, 2010
Beavertail Creek	Road 5719	West Fork District Fish Culverts EA/DN, 2010
Blue Joint Creek, trib 3.8	Road 362	West Fork District Fish Culverts EA/DN, 2010
Britts Creek	Road 49	West Fork District Fish Culverts EA/DN, 2010
Coal Creek, trib 2.1	Road 5660	West Fork District Fish Culverts EA/DN, 2010
Devil Creek	Road 091	West Fork District Fish Culverts EA/DN, 2010
Flat Creek	Road 468	West Fork District Fish Culverts EA/DN, 2010
Gemmell Creek (lower)	Road 5633	West Fork District Fish Culverts EA/DN, 2010
Gentile Creek	Road 5703	West Fork District Fish Culverts EA/DN, 2010
Johnson Creek	Road 091	West Fork District Fish Culverts EA/DN, 2010

Stream	Road #	NEPA Document and Date of Decision
Johnson Creek	Road 5685	West Fork District Fish Culverts EA/DN, 2010
Lavene Creek (lower)	Road 5630	West Fork District Fish Culverts EA/DN, 2010
Nez Perce Fork (lower)	Road 468	West Fork District Fish Culverts EA/DN, 2010
Nez Perce Fork (upper)	Road 468	West Fork District Fish Culverts EA/DN, 2010
Rombo Creek	Road 13462	West Fork District Fish Culverts EA/DN, 2010
Rombo Creek	Road 5715	West Fork District Fish Culverts EA/DN, 2010
Salt Creek	Road 5683	West Fork District Fish Culverts EA/DN, 2010
Sand Creek	Road 1307	West Fork District Fish Culverts EA/DN, 2010
Thunder Creek	WF highway	West Fork District Fish Culverts EA/DN, 2010
Tough Creek	Road 13804	West Fork District Fish Culverts EA/DN, 2010
Two Creek	Road 732	West Fork District Fish Culverts EA/DN, 2010
Two Creek	Road 5650	West Fork District Fish Culverts EA/DN, 2010
Woods Creek, trib 3.8	Road 5669	West Fork District Fish Culverts EA/DN, 2010
Woods Creek, trib 4.5	Road 5669	West Fork District Fish Culverts EA/DN, 2010
Lavene Creek (middle)	Road 5630	Lower West Fork FEIS/ROD, 2010
Lavene Creek (upper)	Road 5630	Lower West Fork FEIS/ROD, 2010
Ward Creek (lower)	Road 373	Lower West Fork FEIS/ROD, 2010
Ward Creek (upper)	Road 373	Lower West Fork FEIS/ROD, 2010
SF Skalkaho Creek 1.6	Road 75	North Zone Fish Culverts DM, 2010
SF Skalkaho Cr, trib 1.4	Road 75	North Zone Fish Culverts DM, 2010
Sleeping Child Creek	Road 75	North Zone Fish Culverts DM, 2010
Sleeping Child Cr, trib 20.1	Road 13235	North Zone Fish Culverts DM, 2010
Sl. Child Cr, trib 3 of 20.1	Road 13234	North Zone Fish Culverts DM, 2010
Divide Creek	Road 75	North Zone Fish Culverts DM, 2010
Threemile Creek	Road 640	North Zone Fish Culverts DM, 2010
Threemile Creek, trib 12.4	Road 640	North Zone Fish Culverts DM, 2010
Willow Creek	Road 364	North Zone Fish Culverts DM, 2010
Butterfly Creek	Road 364	North Zone Fish Culverts DM, 2010
Deep Creek	Road 364	North Zone Fish Culverts DM, 2010
Bear Trap Creek	Road 364	North Zone Fish Culverts DM, 2010
Little Sleeping Child Creek	Road 5604	North Zone Fish Culverts DM, 2010
Ambrose Creek	Road 62179	North Zone Fish Culverts DM, 2010
Ambrose Creek	Road 428	North Zone Fish Culverts DM, 2010
Lick Creek	Road P-1286	North Zone Fish Culverts DM, 2010
Sawmill Creek (lower)	Road 710	North Zone Fish Culverts DM, 2010
Sawmill Creek (upper)	Road 710	North Zone Fish Culverts DM, 2010
Daly Creek, trib 3.3	Road 711	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 2.1	Road 321	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 321	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 1128	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 62435	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 13251	North Zone Fish Culverts DM, 2010
Grizzly Creek	Road 312	North Zone Fish Culverts DM, 2010
Arastra Creek	Road 312	North Zone Fish Culverts DM, 2010
Bush Creek	Road 726	Sula District Fish Culverts EA/DN, 2011
Cameron Creek	Road 1398	Sula District Fish Culverts EA/DN, 2011

Stream	Road #	NEPA Document and Date of Decision
Camp Creek	Sula RD, north	Sula District Fish Culverts EA/DN, 2011
Camp Creek	Sula RD, south	Sula District Fish Culverts EA/DN, 2011
Dick Creek	Road 729	Sula District Fish Culverts EA/DN, 2011
East Fork Camp Creek	Road 729	Sula District Fish Culverts EA/DN, 2011
Laird Creek	Road 370	Sula District Fish Culverts EA/DN, 2011
Lick Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
Lick Creek	Road 5771	Sula District Fish Culverts EA/DN, 2011
Needle Creek	Road 724	Sula District Fish Culverts EA/DN, 2011
Reynolds Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
Sign Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
West Fork Camp Cr, trib 0.1	Indian Trees CG, lower	Sula District Fish Culverts EA/DN, 2011
West Fork Camp Cr, trib 0.1	Indian Trees CG, upper	Sula District Fish Culverts EA/DN, 2011

Forest fisheries biologists periodically monitor some of the culvert replacements and removals to document post-project responses by fish populations and the effects of construction-generated sediment impacts. In 2014, two culvert removals conducted in 2013 (Lodgepole Creek, Road 73279 and East Piquett Creek tributary 2.0, Road 13411) were monitored for fish population responses. These monitoring efforts are summarized below.

Lodgepole Creek Culvert Removal (Sula Ranger District): The Road 73279 culvert on Lodgepole Creek was removed in the summer of 2013. Electrofishing surveys conducted one year later in 2014 did not detect a response by the bull trout and westslope cutthroat trout populations. Similar to past years, low numbers of westslope cutthroat trout were only found downstream of Road 73279. No bull trout were found downstream of Road 73279 in 2014. The Martin Creek Watershed Restoration EA predicted that removing the culvert at the Road 73279 crossing would open up about 0.3 miles of suitable habitat for bull trout and westslope cutthroat trout above the crossing. That has not happened yet. On a positive note, several tailed frog larvae were found upstream of Road 73279 in 2014. Prior to removing the culvert, this species had not been found above the road crossing.

East Piquett Creek Tributary 2.0 Culvert Removal (West Fork Ranger District): The Road 13411 culvert on East Piquett tributary 2.0 was removed in the summer of 2013. Electrofishing surveys conducted one year later in 2014 detected a strong positive response by the westslope cutthroat trout population. Many more cutthroat of all size classes were found upstream of the crossing in 2014. Before the culvert was removed, hardly any cutthroat were present above the crossing. Also, the number and sizes of cutthroat found downstream of the crossing were similar to conditions that existing before the culvert was removed. The Lower West Fork FEIS predicted that removing the culvert at the Road 13411 crossing would open up about 0.1 miles of suitable habitat for westslope cutthroat trout above the road crossing. The length of habitat opened up was underestimated in the FEIS. It is closer to 0.3 miles than 0.1 miles. East Piquett tributary 2.0 contains about 0.8 miles of perennial stream channel upstream of the Road 13411 crossing.

Key Findings of Forest's Culvert Monitoring

- The majority of the culvert replacements have been successful at eliminating fish passage barriers.
- Success depends on meeting five criteria: (1) the culvert is sized large enough to capture the bankfull width of the stream channel; (2) native material is present and stable throughout the culvert barrel; (3) there are no prohibitive drops on the culvert inlet and outlet; (4) the approach and exit grades of the stream channel near the culvert approximate the natural grade of the channel, with no formation of headcut barriers above and below the culvert; and (5) adequate surface flow (depth and volume) is maintained through the barrel at all discharges. When those five criteria are met, fish passage will be provided for native aquatic species to the same extent as the unaltered stream sections in the area.
- Where culverts have been ineffective or only partially effective, the main reasons have been: (1) undersizing the diameter of the culvert (this confines the channel and increases water velocities inside of the culvert, which flushes the substrate out of the barrel); (2) not installing the culvert deep enough into the streambed

(this contributes to the flushing of substrate and the formation of vertical drops on the inlet and/or outlet); (3) not matching the grade of the culvert with the grade of the stream channel (this can cause the formation of headcut barriers); or (4) water flowing subsurface through the barrel at base flows (this is caused by not mixing enough fines into the substrate that is placed inside the barrel).

- An important lesson we have learned during culvert replacement projects on small streams is that a considerable amount of fines must be mixed into the substrate that is placed inside the culvert barrel. Otherwise, the water will flow subsurface through the barrel at base flows (i.e. the French drain effect), forming an impassable seasonal barrier that can last for as long as a decade. Eventually enough fines will get worked into the cracks in the substrate to keep enough water flowing on the surface of the stream bottom through the culvert barrel; however, this may take years to occur.
- Obtaining sufficient funding for survey, design, and contract award is a major bottleneck to replacing fish barrier culverts on the Forest.

Forest fisheries biologists intend to continue to monitor the completed culvert replacements and removals in future years to ensure that adequate fish passage conditions are being provided and maintained (INFISH, PACFISH standard RF-5).

PROJECT LEVEL MONITORING OF FISHERIES & WATERSHED IMPROVEMENT PROJECTS:

Lyman Creek Road 13304 Stream Crossing Rehab Project (Sula Ranger District): In 2009, the Forest fisheries crew placed slash and planted shrubs on three recontoured Road 13304 stream crossings on the North Fork of Lyman Creek. Road 13304 was decommissioned in the fall of 2008. The stream crossings were already overwidened prior to recontouring, and due to their lack of cover, were vulnerable to additional overwidening from livestock in the East Fork grazing allotment. Slash was placed by hand over the top of the stream crossings to discourage livestock entry. An opening was left in the slash to allow livestock a place to ford the stream and drink water. In 2015, after six growing seasons, the recovery of shrubs along the stream crossings was very encouraging as shown in the photos below.

	
Photo 1 - Slash Placement on a Recontoured Road 13304 Stream Crossing, June 2009	**Photo 2 – Same Site after Six Growing Seasons, October 2015**

Buck Creek Seed Production Area Timber Sale Helicopter Landing Rehabilitation Project (West Fork Ranger District): In June 2012, a helicopter landing was constructed just outside of the 150-foot Riparian Habitat Conservation Area (RHCA) surrounding an upper reach of Buck Creek. About two acres of ponderosa pine and Douglas fir forest was clearcut to make room for the landing. When the logging was completed (July, 2012), the slash on the floor of the landing was piled with an excavator into three large burn piles. In June 2013, the landing was seeded with grass and fertilized with an organic fertilizer, but the piles were still not burned, so the rehab work could not be completely finished. The piles were burned in November, 2013. In June 2014, the burn pile scars were planted with grass seed and shrub seedlings (230 snowberry and 230 spirea), then fertilized with an organic fertilizer and covered with straw mulch. The purpose of this project is to restore native vegetation to the landing site and eliminate the risk for future erosion and sediment production. Monitoring conducted in

November 2015 after two growing seasons indicates good grass growth and shrub survival on all three of the rehabbed burn piles. The landing is starting to blend in with the surrounding vegetation.

Photo 3 – Looking up into the Helicopter Landing after Logging has been Completed and the Slash on the Floor of the Landing has been Piled, August 2012.

Photo 4 - Same View Two Years Later, June 2014.

Photo 5 – Slash Piles Prior to Burning, August 2012.

Photo 6 – Slash Pile Burn Scars following Seeding, Planting Shrub Seedlings, and Mulching, June 2014.

Upper West Fork Woody Debris Project (West Fork Ranger District): This is a fish habitat improvement project that the West Fork District implemented in the upper West Fork Bitterroot River in 2014. The purpose of the project is to improve woody hiding cover for bull trout and westslope cutthroat trout in the upper West Fork. A total of 497 beetle-killed lodgepole pine trees were directionally felled by the West Fork fire crew into two segments of the upper West Fork Bitterroot River. 291 trees were felled into a 0.9-mile long lower segment of river between the Deer Creek trailhead and Salt Block Creek. 206 trees were felled into a 0.7 mile long upper segment of river near Salt Creek. The project was funded by the Ravalli County Resource Advisory Committee. Initial monitoring in the fall of 2014 indicated that the new influx of wood was functioning effectively. Significant bank erosion was not visible. The wood also functioned well in 2015. There was no significant downstream drift of the felled trees. This project has successfully met its goal of increasing woody hiding cover for bull trout and westslope cutthroat trout in the upper West Fork Bitterroot River.

<u>Road 13410 Culvert Removal and Stream Crossing Rehab Project (West Fork Ranger District):</u> This project removed three culverts on Road 13410 in the West Creek drainage and recontoured the stream crossings. In June 2015, the crossings were seeded with grass, fertilized, straw mulched, and planted with the following shrub species: 480 rose; 313 snowberry; 85 alder; 50 dogwood; and 28 chokecherry. The purpose of this project was to remove a fish barrier culvert on West Creek tributary 2.0 (a westslope cutthroat trout stream), and restore the natural drainages on the three stream crossings where culverts were removed.

	
Photo 7 – Road 13410 Crossing on West Creek Tributary 2.0 before Recontouring and Planting, July 2014	**Photo 8 – Road 13410 Crossing On West Creek Tributary 2.0 After Recontouring and Planting, June 2015**